NEW YORK ENTOMOLOGICAL SOCIETY
LXXXVIII(1), 1980, pp. 33–82

ABSTRACTS OF PAPERS PRESENTED AT THE 51st ANNUAL MEETING EASTERN BRANCH

ENTOMOLOGICAL SOCIETY OF AMERICA
HERSHEY, PA.
September 26, 27 and 28, 1979

Migration, distribution, and habitat preferences of *Blattella germanica* (L.) in urban, low-income apartments (Dictyoptera: Blattellidae). R. C. Akers and W. H. Robinson, VPI and State Univ., Blacksburg, VA 24061

This study monitored the dispersal behavior and determined density distribution and habitat preferences of *B. germanica* in 3 urban, low-income apartment buildings. Three traps (1-qt. jars) were placed in the kitchen, pantry, and bathroom of each apartment. Two hundred nymphal and virgin adult phenotypic mutant German cockroaches were released into established apartment building populations and trapped at weekly intervals. Trapping proved that this insect could migrate between apartments and integrate with the existing population. Trapping disclosed that the existing German cockroach population was not distributed evenly throughout the buildings. In each building at least one location (=apartment) the number of captured cockroaches was significantly greater than at any other location. In bldg. A, 80% of total cockroaches captured were from apts. 4 and 5; bldg. B, 75% were from apt. 1; bldg. C, 55% were from apt. 6. This focal location corresponded to the apartment with the most severe sanitation problem. Habitat preferences differed at the trapping sites in the 3 buildings: bldg. A, kitchen—22%, pantry—39%, bathroom—39%; bldg. B, kitchen—21%, pantry—37%, bathroom—42%; bldg. C, kitchen—41%, pantry—21%, bathroom—38%. The German cockroach dominated other cockroach species in the urban, low-income apartments studied. Laboratory-reared cockroaches were able to disperse and integrate with the established population.

Comparative toxicity of etrimfos to gypsy moth larvae and house flies. M. Akram and A. J. Forgash, Dept. of Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Etrimfos (*O*-*O*-dimethyl-*O*-(6-ethoxy-2-ethyl-4-pryimidinyl) phosphorothioic acid ester), a new organophosphate insecticide was tested against 2nd, 3rd, 4th, and 5th instars of gypsy moth larvae (*Lymantria dispar* L.) and susceptible and multi-resistant strains of adult house flies (*Musca domestica* L.). For each dosage, 50 insects were tested in five replicates containing 10 insects per replicate. Etrimfos was applied in acetone solution to the thoracic dorsum with a microapplicator. Results showed an increased tolerance of gypsy moth larvae to this chemical with larval growth. Individuals of the 3rd-, 4th-, and 5th-instars can tolerate up to 2.6, 5.2, and 28.8 times as much as 2nd-instar larvae. In gypsy moth an active microsomal oxidative system has been reported, presumably, the increase in tolerance to etrimfos of later instars is related to the changes in activity of the mixed-function oxidases. Two susceptible strains (WHO/IN and Wilson) of house fly showed a relatively high sensitivity to etrimfos. However, Es and A strains, which were cultured under the pressure of resmethrin and diazinon, respectively, were 4.5 and 14.2 times tolerant to this compound. Multiresistance to insecticides as the result of selection with a single material is well recognized; presumably, diazinon selection was responsible for increased tolerance to etrimfos. The lower tolerance of ES suggests a less developed or different mechanism of resistance than A strain.

Release of oviposition-deterring pheromone by apple maggot flies, *Rhagoletis pomonella* (Walsh) (Diptera: Tephritidae) A. L. Averill and R. J. Prokopy, Dept. of Entomol., Univ. of Mass., Amherst, MA 01003

Following egglaying into a fruit, the female apple maggot deposits a marking pheromone on the fruit surface which deters subsequent oviposition. Two techniques were developed to accurately quantify the amount of marking pheromone deposited. 1) Dusting a recently marked fruit with dry magnetic toner (Olivetti) used in paper copying machines renders the pheromone trail readily apparent. 2) Feeding ♀♀ amaranth results in a trail which is conspicuously dyed. Pheromone trail length and area are then measured with an ocular micrometer. For 14-day-old ♀♀ ovipositing in 15 cm diameter hawthorns, the average length of pheromone trail was 52.8 mm, the average width .05 mm and the average area 2.7 mm^2 ($N = 99$). Old flies produce smaller trails than young flies and starved flies deposit much less material than unstarved flies. There was a low, though significant, positive correlation ($r = +0.315$) between time spent in ovipositor dragging and area of pheromone trail. In individual flies, the degree of variability in pheromone trail area was large among successive dragging bouts within single days. The presence of amaranth dye (internally confined to the digestive tract) in the pheromone trail suggests that a portion of the pheromonally active substances may be released from the digestive tract. Behavioral bioassays of organs of the digestive and reproductive tracts strongly implicate the hindgut (as well as the ovary) as a site of pheromone production or accumulation.

Oviposition response of the horn fly (Diptera: Muscidae) to environmental and manure characteristics, N. P. Bacon, West Va. Univ., Morgantown, WV 26506

Horn fly control efforts have previously been directed primarily at chemical, biological or sterile methods. Little work on behavioral control has been carried out. The purpose of this study was to investigate horn fly oviposition site selection behavior. Horn flies only oviposite on freshly defecated feces (ca. 10 min), and then only on select pats. The responses of the flies to selected environmental, manure and host-fly interaction characteristics were studied on a rural Pennsylvania dairy farm. Fly number response, used to assess oviposition preferences, indicated that manure pats which were defecated in areas of full sunlight, and on grass or soil substrates attracted the largest number of flies. Pats which were large in size (22.8^{+} cm), tall in height (4.3^{+} cm), and had features which gave topographic relief to the pat (e.g. edge, cracks, depressions) also increased fly response. The expression of these topographic features was found to be dependent on substrate, pat moisture content, and pat height. Fly response was least when manure pats were defecated under roofed areas, at night, on liquid substrates, on pats with small height-size ratios, and on pats which lacked topographic relief features.

These results offer another avenue of investigation for biological control of the horn fly.

The impact of the soil systemic, aldicarb and the foliar insecticide, pirimicarb on potato plant growth. B. A. Bajusz, Z. Smilowitz, T. P. Mack, F. L. Petitt, C. A. Martinka, and M. E. Whalon, Pesticide Res. Lab., Pennsylvania State Univ., University Park, PA 16802

In field experiments designed to evaluate the impact of an insect pest on crop growth, different application rates of insecticides are often applied to obtain insect populations of different levels. However, to accurately evaluate the insect component the impact of these insecticides on the growth of the plant must be known. A field experiment designed to assess the effect of different green peach aphid, *Myzus persicae* (Sulzer), densities on plant growth was expanded to include tests on the impact of the foliar insecticide pirimicarb and soil systemic aldicarb on plant growth and development. The data indicated that both compounds appear to affect potato growth and development. Pirimicarb applied on a weekly basis to fields containing five aldicarb rates, 0–35 lb ai/A, reduced foliage biomass throughout the season but did not appear to affect tuber biomass. Aldicarb appeared to prolong the period of haulm growth and increasing soil dose delayed plant senescence. The effects observed with increasing aldicarb concentrations closely paralleled those associated with decreasing aphid densities, and could have erroneously been attributed solely to differing aphid numbers. Further experimentation is currently underway to increase our understanding of these findings. It was concluded that the effects of chemical insecticides on plant growth must be known before they are used in plant growth experiments to manipulate insect population size.

Effect of electromagnetic devices on subterranean termites (*Reticulitermes*), drywood termites (*Incisitermes minor*), and German cockroaches (*Blattella germanica*). R. Beal, U.S.F.S. Gulfport, MS 39501, M. Rust and D. Reierson, U. of Cal., Riverside, CA 92521, D. S. Dalton U.S.E.P.A., Wash. DC 20460 (proj. off.)

There has been a recent increase in the sale of "electromagnetic" pest control devices for use against pest insects and rodents in private homes and in commercial and industrial sites. EPA grants to 2 institutions tested the efficacy of three devices. Field tests with subterranean termites exposed to the devices in Mississippi for 6 months showed no significant effect on tubing activity or frequency of stake attack. Field tests in roach infested apartments in Los Angeles showed no measurable differences in control of roach populations between exposed and unexposed buildings. Lab tests with roaches showed no measurable differences on behavior of roaches in a repellent/nonrepellent choice box situation. In addition, starting with either adult or nymphal roaches there was no significant difference in the resultant number of roaches after 12 weeks of exposure to the devices. Devices had no effect on egg capsules of *Periplanta americana*. In lab tests with drywood termites, no significant differences were found in mortality, amount of wood consumed, or increase in termite biomass after a 3 month exposure to the devices. As a result of these tests and tests against 3 rodent species, EPA initiated enforcement action under the Federal Insecticide, Fungicide and Rodenticide Act to stop the distribution of these devices because of false and misleading claims.

The effects of mowing on the guild of sap-feeding insects associated with Kentucky bluegrass. Richard A. Bean and Robert F. Denno, Department of Entomology, Univ. of Maryland, College Park, MD 20742

Four species of Auchenorrhyncha dominate the sap-feeding guild of insects associated with Kentucky bluegrass. They are in decreasing order of abundance, *Psammotettix lividellus* (Zetterstedt), *Graminella nigrifrons* (Forbes), *Doratora stylata* (Boheman) (Cicadellidae), and *Delphacodes lutulenta* (Van Duzee). The densities of these sap-feeders were measured in mowed (cut monthly) and uncut plots throughout the year to test the effects of disturbance and habitat modification on the structure of the guild. *G. nigrifrons* is a fugitive species colonizing plots as adults in spring developing a single generation and then emigrating in June. This species achieved equal densities in both uncut and mowed plots. *D. lutulenta* and *D. stylata* are residents and overwinter as adults and nymphs respectively. Adults of these species are mostly brachypterous and significantly lower densities occurred in the mowed plots. The adults of the resident leafhopper *P. lividellus* are macropterous and occurred at equal densities in cut and control plots. Fugitive species were least affected by mowing followed by macropterous residents. The densities of species that are closely tied to resources (brachypterous) were most affected by habitat perturbation.

Sweet corn insect pest management in New Hampshire. J. S. Bowman and A. T. Eaton, Univ. of New Hampshire, Durham, NH 03824

A modification of the New Jersey sweet corn IPM program has been of economic value to participating growers for the past 3 seasons (1977–1979). The program is based upon utilizing grower personnel trained to scout fields for European corn borer and fall armyworm feeding injury and operate black light traps to detect corn earworm moth populations. The results of whorl stage treatments of granular and spray treatments at 15% leaf feeding damage demonstrated economic control of first brood European corn borer with Dyfonate 10GK at 1.5 lb. ai/A or Furadan 10G at 1.0 lb. ai/A applied as single treatments or two applications (5 days apart) of Penncap M 2F at 0.5 lb. ai/A. Promising results have also been obtained with Pounce 3.2EC at 0.1 lb. ai/A and Orthene 75S at 1.0 lb. ai/A. During 1977 and 1978 the late arrival of the corn earworm moths along with low late season populations resulted in savings of two to five applications of pesticides for an average value of $18.38 per acre. The number of participating growers has increased from three in 1977 to ten in 1979 representing 16 percent of the total sweet corn acreage in New Hampshire. Problems associated with this grower-operated program include difficulty in training personnel to identify light trap catches as well as data gaps in scouting reports and light trap catches when traps are inadvertently not operated. Also, an unreliable source of black light traps has created problems in bringing new growers into the program.

Bait sampling for white grubs (Coleoptera: Scarabaeidae) and wireworms (Coleoptera: Elateridae) in Virginia corn land. S. P. Briggs and W. A. Allen, Dept. of Entomol., VPI and State Univ., Blacksburg, VA 24061

Nineteen fields in two Virginia counties were used to confirm a solar baiting technique for wireworms. In Westmoreland County, Virginia, eight fields in a corn-small grain-soybean rotation and five in a corn-corn agronomic system were tested. In Montgomery County, Virginia, six fields in a corn-corn system were used. The bait consisted of 30 cc of a corn-wheat mixture (1:1 ratio) buried 15.0 cm deep and covered with black and clear plastic. Baits were retrieved after remaining in the field for 14–15 days and all wireworms and white grubs were collected. In addition to baiting, 40 cylindrical soil samples (20.3 cm diameter, 38.0 cm deep) per field were taken to correlate relative sample (bait) populations with absolute sample (core) populations.

A list of the white grub and wireworm species found was established. The baiting technique is shown to be effective on both white grubs and wireworms in Virginia.

Toxicity of the IGR L7063 to *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae) and two associated parasites. J. R. Brushwein and J. Granett, Univ. of Maine, Orono, ME 04469

Laboratory tests of Insect Growth Regulators (IGRs) have demonstrated high levels of toxicity to the spruce budworm, *Choristoneura fumiferana*. Field studies have indicated potential use of IGRs for spruce budworm control programs. Our purpose was to determine comparative toxicities of L7063 to spruce budworms and two associated hymenopteran parasites *Apantales fumiferanae* Vier. (Braconidae) and *Glypta fumiferanae* (Vier.) (Ichneumonidae). Overwintering budworm larvae on white spruce were collected in the laboratory. Emerged second stage budworms were reared on artificial diet until just prior to the instar tested. Newly molted, unfed 4th and 5th stage budworms were fed artificial diet containing L7063 until larval mortality or parasite emergence. Concentrations of L7063 in diet ranged from 0.063–2.4 ppm. The LC_{50} for field collected, unparasitized budworms was between 0.063 and 0.10 ppm. Larval *A. fumiferanae* and *G. fumiferanae* mortality was determined by dissection of L7063 killed hosts. Parasitism rates of *A. fumiferanae* and *G. fumiferanae* were determined by host dissections and by numbers of emerged parasites. Parasitism rates for eight experiments ranged from 4.6 to 27.9% and 2.9 to 12.9% for *A. fumiferanae* and *G. fumiferanae*, respectively. For all L7063 concentrations tested, little mortality occurred in stage 1 and 2 *A. fumiferanae* larvae or stage 1, 2, and 3 *G. fumiferanae* larvae. Diet concentrations of L7063 between 0.42 and 2.4 ppm caused mortality of all 3rd stage *A. fumiferanae* with death occurring before emergence from the host.

Status of a biological control program against the cereal leaf beetle, *Oulema melanopus* (L.) (Coleoptera: Chrysomelidae). T. L. Burger, USDA, APHIS, Cereal Leaf Beetle Lab., Niles, MI 49120

The cereal leaf beetle, *Oulema melanopus* (L.), an Eurasian pest of small grains, was first observed in the United States in 1959 in Berrien County, MI. Aided by the prevailing winds, its range has expanded primarily to the East to include 20 states and one Canadian province. Through a cooperative Federal and State program five hymenopterous parasites: *Tetrastichus julis* (Walker); *Diaparsis carinifer* (Thomson); *Diaparsis* n.sp.; *Lemophagus curtus* (Townes); and *Anaphes flavipes* (Foerster) have been introduced as an attempt at multiple species biological control of this pest. To date one or more of these parasites have been released and/or recovered in 18 states and one Canadian province. Results obtained from monitoring sites in states where the program was first initiated, revealed high rates of parasitization of eggs and/or larvae of the pest. Overall seasonal egg and larvae parasitization rates of 70 and 90 percent respectively recorded from low, medium, and high host densities. States, such as MI, IN, OH, PA, and NY, which experienced economic damage over moderately large areas in the past, no longer have significant pest populations where high parasitization rates had been encountered for one to two years. To date no single species of the introduced parasites has exhibited dominance throughout its established range in the United States. States are now in the process of assuming total responsibility for the program.

Growth and survival of *Hylotrupes bajulus* (L.) larvae under favorable and unfavorable conditions (Coleoptera:Cerambycidae). K. F. Cannon and W. H. Robinson, Dept. of Entomol., VPI and State Univ., Blacksburg, VA 24061

Hylotrupes bajulus (L.), the old house borer, is unique among Cerambycids in that it can survive and reproduce in seasoned softwoods. Larvae bore just under the surface, hollowing out the outermost layer of wood before continuing deeper into the wood. Larvae seldom break the surface, thus preventing early disclosure. Detection in wood does not usually occur until larvae are nearly full grown or adult insects emerge. Severity of damage produced by this pest is linked to the developmental time of the larvae; it can live and feed up to 10 years in structural wood. Previous investigations and reports of *H. bajulus* in the U.S. have relied on European data and field observations. The data presented here are based on a laboratory colony and controlled field experiments of *H. bajulus* in Virginia. The experiment was designed to study feeding, growth, and survival of *H. bajulus* under favorable and unfavorable environmental conditions. Results of the feeding and growth studies reveal that under field and laboratory conditions small (2.8–86.6 mg) larvae consume more wood per mg body weight than medium (106.7–197 mg) and large (208.5–430.9 mg) larvae. Excrement (frass) is proportional to consumption. Wood consumption and weight gain are influenced by climatic conditions. Larval survival was not affected by climatic conditions during the duration of the experiment.

Fungicidal inhibition of *Beauveria bassiana,* a pathogen of the Colorado potato beetle (*Leptinotarsa decemlineata* Say.) (Coleoptera: Chrysomelidae). R. A. Clark, Dept. of Plant Path. and Entomology, Univ. of Rhode Island, Kingston, RI 02881

Fungicides used to control *Phytophthora infestans,* the late blight pathogen, may limit the development of epizootics of *B. bassiana* in CPB populations. Using agar-diffusion, 3 fungicides were bio-assayed for inhibition of *B. bassiana.* Plates were inoculated with a spore suspension of 10^6 spores/ml. Paper discs treated with fungicide were placed on the plates. Plates were incubated 5 days at 25 C. Inhibition zones indicated *B. bassiana* was inhibited by 3 fungicides. The insecticide azinphos methyl (Guthion) also had a synergistic effect with at least one fungicide.

To refine quantification of the degree of inhibition, the fungus was grown in Emerson's Broth with doses of the pesticides added to the medium. Flasks were incubated on a rotary-shake table at 25 C. For 7 days, at 24-hr intervals, the contents of the culture flasks were filtered, the mycelial mat dried and weighed. Although conventional fungicides (Manzecob, metiram, chlorothalmil) retarded mycelial growth rate, the late blight specific experimental CGA 48988 had little effect and thus holds the most promise for use in integrated pest management for potatoes.

Insemination frequency and sperm precedence in the German cockroach (Dictyoptera: Blattellidae). D. G. Cochran, VPI and State Univ., Blacksburg, VA 24061

A question of fundamental importance to insect reproductive biology is how frequently a female can be effectively inseminated. The problem can best be approached by use of genetic-mutant markers which allow positive proof of parentage. Using the recessive marker rose eye (*ro*), it has been shown that adult female German cockroaches, *Blattella germanica* (L.), can mate effectively with more than one male. The most common period for remating is between production of successive egg cases, but remating also took place between the first mating and production of the first egg case. In the first instance remating occurred in about 20% of the females studied while in the second instance remating was rare.

Because the German cockroach female normally produces only 3 or 4 egg cases, the later ones with reduced numbers of progeny, the total impact of second matings on all progeny produced tends to be small. That impact is further diminished by the prevalence of incomplete sperm precedence which allows sperm from the first mating to function even after a second successful mating. These results show that monogamy is common in this species, but that superimposed upon it is the willingness of the female to remate occasionally. Presumably remating is opportunistic and occurs in response to sperm depletion in the spermatheca.

Parahost behavior of adult *Gasterophilus intestinalis* (DeGeer) (Diptera:Gasterophilidae). S. E. Cope and E. P. Catts, Dept. of Entomol. and Appl. Ecol., Univ. of Delaware, Newark, DE 19711

In Delaware adult horse bot flies occur from mid June to mid October. Adult activity was closely observed in the vicinity of grazing equines. Individual flies were followed by a mark and release method. The onset of daily parahost activity was correlated to temperature. Males hover intermittently around hosts during the mating period and are rarely seen after mid day. Male flies also defend single or clustered horses from other males through the use of audible encounters and aggressive pursuit. Female fecundity approximated 1000 eggs. The majority of oviposition was completed by mid day and the egg-laying pattern varied in location and concentration. Females are capable of ovipositing the full egg complement in less than 1 hour and exhibit a broad range of tolerance to environmental conditions. Flight characteristics of females are indicative of physiological age. Longevity of adults in their natural habitat is 1–2 days. Adults which were captured in the field and held under laboratory conditions lived for a slightly longer period of time. These studies represent an advance in the knowledge of the biology of *Gasterophilus intestinalis* and help to establish a basis for future experimentation with regard to the development of trapping devices as a method of augmenting host treatment as a control measure.

USDA Procedure for acting on new pest problems. R. L. Cowden, USDA, APHIS, PPQ, Hyattsville, MD 20782

Of the economically important pests that occur in this country, most have come in from foreign sources. With the current widespread interest and concern in pesticides, environmental pollution, and energy conservation, early detection and decision as to what should be done has become increasingly important. It is the function of the New Pest Work Group to review available data and make recommendations to the Deputy Administrator of the Animal and Plant Health Inspection Service as to the best courses of action concerning newly reported plant pests. Upon detection of a new insect species of pest potential, a determination is made of its probable economic importance in this country. Experts from various Federal and State agencies, universities, industry, and others are called together to discuss and provide advice on future courses of action. Most new species detected are likely to be of little economic importance. A second group may cause concern because of the uncertainty of their pest potential in this country. Thirdly, there are others which are known economic pests on crops or in situations similar to those in the area where they are detected. In the latter two categories, the temporary quarantines, control or eradication, parasite introduction, crop destruction, and other options are considered when recommending action.

Herbivorous insects causing mortality of pine seedlings in an old field. W. J. Cromartie, M. A. Rivera, J. Gfrorer and D. Maser, ENVL, Stockton State College, Pomona, NJ 08240

As part of a study of establishment of Pitch Pine (*Pinus rigida*), seedlings 1–8 yr old in an abandoned agricultural field were censused, tagged and sampled during two years. Percentage defoliation was estimated in spring, summer and fall, 1978, and measured in spring, 1979, on a sample of 30 trees. The principal defoliator was the Red-headed Pine Sawfly (*Neodiprion lecontei* Fitch). Damage by shoot borers (mainly *Rhyacionia* sp.) and sucking insects, including a scale (*Toumeyella* sp.) and aphids (*Cinara* sp.) was also estimated. Intensity of herbivore attack was variable from tree to tree. Thirty-five percent were killed or severely stunted by defoliation or loss of numerous shoots to tip moths. Some trees, however, were virtually unaffected, even when they were adjacent to trees that were killed. Defoliation levels increased from 1978 to 79, except on trees that were 90% defoliated prior to spring, 1978; these showed signs of recovery. A correlation was found between foliar concentrations of potassium and level of defoliation. It is hypothesized that a positive feedback mechanism is responsible for the pattern of herbivore attack on young Pitch Pine.

Geographic variation in vagility in the milkweed beetle, *Tetraopes tetraopthalmus* (Forster) (Coleoptera: Cerambycidae). M. A. Davis, Dartmouth College, Hanover, NH 03755

This study shows that extensive variation in flight and migratory behavior exists within and between *Tetraopes* populations. The vagility of milkweed beetles in different populations in New England was compared by flight testing the beetles with a still air tethering device.

The vagility of populations varied seasonally, with peak vagility coinciding with the peak flowering period of its host plant. Most beetles tested were relatively sedentary, although each population possessed a certain proportion of beetles that were highly vagile. Populations differed significantly in the proportion of highly vagile beetles they contained. It is hypothesized that this geographic variation in vagility is due to differences in the age and remoteness of milkweed patches throughout the range of *Tetraopes*.

Factors affecting honey bee *Apis mellifera* L. (Hymenoptera: Apidae). Foraging on birdsfoot trefoil (*Lotus corniculatus*). G. L. DeGrandi and C. H. Collison, Penn. State Univ., University Park, PA 16802

Honey bees are essential for commercial seed production of birdsfoot trefoil because of self-sterility and incompatibility systems that make cross-pollination necessary. Six commercial varieties, Dawn, Empire, Mackinaw, Missouri-20, Kentucky-Ecotype, and Viking were evaluated for flower production, nectar secretion, and attractiveness to honey bees. Nectar was removed from one-day-old florets with a micropipette and sugar concentration determined with a Baush and Lomb refractometer. Both greenhouse and field studies of first year growth were conducted simultaneously. The total volume of nectar and sugar concentration between varieties did not differ significantly at the 0.05 level of probability in either study. Flowers contained between 0.21–0.25 μl of nectar, and had a sugar concentration of 14.6%–17.5%. Significant differences were found in flower production, with Empire producing the most florets (mean of 497/10 plants) throughout the season. Viking and Kentucky-Ecotype were the first to bloom, and averaged the least, 21 and 48 florets, respectively. No significant differences were found between Missouri-20, Dawn, or Mackinaw, with each averaging between 88–99 florets. Flowering and attractiveness to honey bees was significantly correlated, with Empire plots having the greatest foraging activity and Viking plots the least. Missouri-20, Dawn, and Mackinaw were equally attractive, but were not foraged as heavily as Empire.

The mayfly fauna (Ephemeroptera) of two Connecticut streams. P. J. Dodds, Univ. of Connecticut, Storrs, CT 06268

The life histories and ecological relationships of mayflies inhabiting two Connecticut streams were studied. Forty-eight species were collected from each stream. Ten were selected for life history analysis utilizing head length frequency classes and arbitrary age groups based on wing pad development. This was correlated with adult flight periods to determine temporal partitioning of the habitat. Two basic life history patterns were found. In the first, nymphs appeared in late summer and autumn and grew throughout the winter, emerging in the spring. Nymphs and adults of the second type were both present in the summer with eggs diapausing for most of the year. Most species showed a seasonal succession with narrow temporal overlap, although species of the genus *Ephemerella* exhibited more significant overlap. The mayfly community as a whole illustrated seasonal changes with greatest differences occurring between the two rivers in early summer and fall. Numbers increased in early spring and decreased thereafter until early summer, when hatching of summer species induced another increase; numbers declined again through the summer months. Species diversity also decreased from spring to fall in both rivers. Such changes in the mayfly fauna were associated with life history phenomena, including delayed hatching, maturation, and adult emergence.

Impact of predators and parasites on the survival of *Rhinocyllus conicus* Froelich (Coleoptera: Curculionidae). P. F. Dowd and L. T. Kok, Dept. of Entomol., VPI and State Univ., Blacksburg, VA 24061

Several predators and parasites frequently observed in the vicinity of thistle plants infested by the thistle head weevil, *Rhinocyllus conicus* Froelich, were studied during 1978 to update their impact on *R. conicus*. Potential predators were collected from the flower heads of musk thistle (*Carduus nutans*) in Pulaski Co., VA during the oviposition period of *R. conicus* in the spring. Exposure tests using insects in the families: Cleridae, Cantharidae, Lampyridae, Elateridae, Nabidae, and Formicidae indicated no predation on the eggs and adults of *R. conicus*. However, similar studies with spiders in the families Salticidae and Thomisidae showed predation on the adult weevils and third instars. Salticid spiders appeared to prefer larvae (6.5/wk), while the thomisid spiders were more important predators of adult weevils (3/wk). These spiders, however, were not abundant and thus were not important mortality factors. Parasitism was studied by collecting 50 terminal heads of plumeless thistle (*Carduus acanthoides*) from each of 2 selected sites, and 100 terminal heads and peduncles of musk thistle from each of 3 sites during early summer. Twenty percent of the heads were dissected soon after collection and those remaining were held for parasite emergence. Four species of parasites were recovered, 2 of which were previously reported on *R. conicus*. Rates of parasitization of *R. conicus* in the 2 plumeless thistle sites were 0 and 14.8 ± 8.7%, as compared to 5.0 ± 1.8%, 1.2 ± 1.3% and 0.27 ± 0.55% in the 3 musk thistle sites. The rate of parasitization generally was not sufficiently large to be a major mortality factor of *R. conicus*.

Ovipositional preference of the grape colaspis, *Colaspis brunnea* (Fab.) (Coleoptera: Chrysomelidae) in North Carolina. A. T. Eaton, R. L. Rabb and J. W. Van Duyn, Univ. of New Hampshire, Durham, NH 03824, and North Carolina State Univ., Raleigh, NC 27650

The effects of four different soils on ovipositional preference of the grape colaspis were investigated in field cage and laboratory tests. A 1976 field cage test (RCB design) utilized soybeans growing in caged areas measuring 2.74 × 1.83 m. A thin layer of test soil occupied the top 3 cm of the soil profile; the caged areas were divided into quadrants for the four soils. Adults of *Colaspis brunnea* were swept from surrounding soybean fields and released inside the cages. After allowing six weeks for oviposition and growth of the larvae, soil samples were taken inside the cages. The number of larvae recovered from the soil demonstrated a preference for clay loam followed by loam, muck, and sand. The former were highly creviced soils; the latter had few surface crevices. The following year, repetition of the test in the field and laboratory gave similar results. The lab test utilized cylindrical plastic containers, 15 cm in diameter × 4 cm deep, into which 10 male and 10 female *Colaspis* were placed. After several days, eggs were carefully recovered from the soil, and the number of eggs recovered in each quadrant (soil type) were compared. Additional testing with the same containers demonstrated a preference for creviced soil over smooth soil. Further laboratory observations suggested that adults preferred to oviposit in areas of low light intensity.

Presocial behavior in *Cerceris watlingensis* Elliott & Salbert (Hymenoptera: Sphecidae). N. B. Elliott and T. Shlotzhauer, Hartwick College, Oneonta, NY 13820

Earlier studies had shown that females of *C. watlingensis* shared nests. Marked females were observed on San Salvador Island, Bahamas, during November and December, 1978 to determine the extent of nest sharing and switching. Newly emerging females remained in the parental nest for several days. In most cases several females provisioned these nests during this period. After a few days the young females switched to new nests. Nest switching was preceded by a day's searching activity during which females flew restlessly about, often biting the sand's surface. In some cases the new nests may have been freshly dug, but we observed females taking over already established nests. Females always chose new nests at least one meter away from their original nests, although entrances in this species were often only a centimeter apart.

Activities of the individuals in shared nests were compared, and one was always a more effective provisioner. The major provisioner always left the nest first in the mornings, spent less time in the nest between provisioning trips, and provided more prey per day. The other females spent more time within the nest, often with the head in the entry. This behavior served to guard the nest against enemies, especially ants, the major predators of the species. Thus there is the beginning of division of labor in this species.

Effects of dietary nitrogen on ^{14}C-glycine and ^{14}C-formate incorporation into body urates of *Blattella germanica* (Dictyoptera: Blattellidae). J. A. Engebretson and D. E. Mullins, VPI and State Univ., Blacksburg, VA 24061

The relationship of dietary nitrogen to urate metabolism and the incorporation of two radiolabeled precursors has been examined in *Blattella germanica*. Male and female cockroaches maintained on diets ranging from 0 to 42% protein and injected with either ^{14}C-glycine or ^{14}C-formate were examined for retention of total radioactivity in whole insects and their urate fractions.

Urate synthesis/storage increased in cockroaches maintained on the higher protein diets, whereas urate levels decreased in those insects on low nitrogen diets. Greater radiolabel retention was found in insects maintained on the high protein diet when injected with either ^{14}C-glycine or ^{14}C-formate; however, cockroaches injected with ^{14}C-formate retained almost twice as much radioactivity as those injected with ^{14}C-glycine.

Incorporation of ^{14}C-glycine into the urate pool varied significantly among insects maintained on different dietary regimes. Insects on higher dietary nitrogen levels incorporated more radiolabel into urates. The pattern of ^{14}C-formate incorporation into body urates differed from that observed for ^{14}C-glycine. More radioactivity was found in the urates from insects maintained on the intermediate nitrogen diets. Insects fed a 42% protein diet incorporated significantly less ^{14}C-formate into their body urates. These levels were comparable to those obtained from insects maintained on 0 and 5% protein diets.

Niche relations of stinkbugs (*Podisus* spp.) attacking eastern tent caterpillars. E. W. Evans, Cornell Univ., Ithaca, NY 14853

The importance of interspecific competition in shaping the life history characteristics of insects is presently unclear. The present study addresses the issue by considering patterns of prey exploitation of three species of predatory stinkbugs, *Podisus maculiventris, P. placidus,* and *P. modestus* (Hemiptera: Pentatomidae), which were found together, attacking eastern tent caterpillar larvae (Lasiocampidae: *Malacosoma americanum*). Tents of *M. americanum* and more than 500 associated adults of the three predator species were censused in 1977–79 near Ithaca, N.Y. While only *Podisus* *maculiventris* adults were found about the tents during the first half of the larval period of *M. americanum,* adults of all three predators were found together about the tents thereafter. During this period of overlap, the three predators did not differ in the sizes of prey they consumed, despite differences in the sizes of these predators themselves. The three predators did differ, however, in their locations: *P. placidus* was most often found inside tents, *P. maculiventris* on the surface of tents or within 30 cm of the tents, and *P. modestus* more than 30 cm from the tents. These results suggest that the three species have diverged in where they hunt for prey. As individual predators readily attack prey already subdued by other individuals, this divergence in site of hunting may reduce interference in consumption of prey, and this may reflect the importance of interspecific competition in determining how these predators exploit tent caterpillars.

Effect of temperature and light on aggregation behavior of *Aedes stimulans* larvae (Diptera: Culicidae) in a woodland pool. G. P. Fernald and J. F. Burger, Dept. of Entomol., Univ. of New Hampshire, Durham, NH 03824

Behavior of *Aedes stimulans* larvae in southeastern N.H. was studied relative to daily changes in water temperature. Observations were made on a 41 × 2.5 m woodland pool divided into 14 sections. Temperature readings and larval counts were taken in each section from initiation of hatching at 2.7°C (March 6, 1979) until adult emergence was complete (May 12, 1979). Maximum vertical and horizontal temperature gradients occurred on bright, sunny days. Maximum surface temperatures occurred over 5 cm deep margins in the shallower sections. Aggregating behavior of *A. stimulans* was a complex response to temperature and incident solar radiation. These were major factors initiating and directing horizontal movement of larvae. Diurnal warming and nocturnal cooling induced the daily formation and dispersal, respectively, of larval aggregations. Vertical and horizontal distribution was more uniform when temperature gradients were low. Larvae were mostly inactive below 5°C except for vertical movement associated with feeding and respiration. Horizontal movement in response to light was greatest at 7–10°C. Above 10°C horizontal movement was a thermotactic response to increasing temperature. Larvae did not cross thermal barriers more than 2°C below temperatures in the aggregation site. Larvae tended to move toward areas of higher temperature until water temperature in shallow sections reached the optimum (18–19°C). Thereafter, larvae tended to avoid areas of higher temperature (>20°C) and seek areas of lower temperature in deeper sections of the pool.

A definitive method for determining pear seedling resistance against pear psylla, *Psylla pyricola* Foerster (Hemiptera: Psyllidae). B. J. Fiori[1] and R. C. Lamb[2], SEA, USDA, Geneva, NY[1]. New York State Agric. Expt. Stn., Geneva, NY 14456[2]

Reduction of egg deposition and nymphal mortality have been shown to be responsible for resistance against the pear psylla in *Pyrus ussuriensis* and crosses of *P. ussuriensis* with *P. communis*. Exposure of candidate seedlings to unconfined adults and counting the number of nymphs per seedling after appearance of 5th instars (25–30 days) has been suggested and employed to determine resistance. The method does not permit seedling replication in a single test, does not exclude preference and permits some seedlings to escape infestation and remain unclassified. To avoid these serious disadvantages the following method was devised using known resistant and susceptible pear stock grafted to potted rootstock. Dialysis tubing was used to confine 5♂ and 5♀ psylla adults on two leaves of each plant for a 10-day period; tubing and adults were removed, eggs were counted and reduced to 15 per leaf by rubbing. After an additional 15–20 days (appearance of 5th instars) nymphal counts were taken. In 4 tests using 2 plants each of 1 resistant and 2 susceptible stocks, average egg deposition and number of nymphs was reduced 57–83% and 87–100% respectively on resistant stock. Results indicate the number of eggs deposited within 10 days can be used to determine resistance of candidate seedlings, thus reducing testing time from 25–30 to 10 days, and that known resistant and susceptible standards should be included in each test. The method provides for at least 2 replications per seedling, excludes preference and does not allow escapes.

PTTH and ecdysone release in last instar larvae of the European corn borer, *Ostrinia nubilalis* (Hübner) (Lepidoptera: Pyralidae). D. B. Gelman and D. K. Hayes, Insect Reproduction and Livestock Insects Laboratories, USDA, Beltsville, MD 20705

European corn borer larvae were reared under a photoperiodic regimen of 16 hours of light and 8 hours of dark and a temperature of 30°C, conditions which promote pupation. Based on a comparison between % pupation in controls (unligatured larvae) and % pupation or formation of intermediates in ligatured larvae, it was concluded that PTTH release, under the above conditions, begins approximately 24 hours before the formation of the pharate pupa, and that ecdysone release by the prothoracic glands occurs at least 6–9 hours after PTTH release. Both PTTH and ecdysone release as well as the formation of the pharate pupa appear to be rhythmic in that PTTH release and the formation of the pharate pupa are associated with the onset of darkness, while ecdysone release is associated with the onset of dawn. Ligatured larvae which did not show signs of pupation by 96 hours post ligation never did show such signs, although most remained alive for 30–40 days. This indicated that effective concentrations of PTTH are not released before the 24 hours preceding pharate pupal formation. Since many headless pupae did show adult development, including completely formed wings and legs with scales, it can be concluded that neurohormones and hormones needed for this development and produced by structures in the head have been released before the formation of the pharate pupa.

Effects of decapitation on ecdysone and vitellogenin titers and egg maturation in *Aedes aegypti* (Diptera: Culicidae). J. T. Greenplate, Cornell Univ., Ithaca, NY 14853

Egg development in *Aedes aegypti* is governed by an intricate control system involving several hormones. Early studies were limited to measuring oocyte growth alone. However, recent discoveries have allowed the study of a sequence of intervening steps and products. Early decapitation experiments associated egg maturation with the release of a factor from the head at 4–8 hr after blood-feeding. Later *in vitro* research suggested that a brain hormone (released after blood-feeding) prompts the ovary to secrete ecdysone which stimulates the fat body to synthesize vitellogenin, the yolk protein precursor. *In vivo* support for this scheme has been lacking, but recent studies by this author add such support. *A. aegypti* females were decapitated at various times after blood-feeding. At 20 and 48 hr post blood meal (PBM), the animals were dissected and divided into two groups: females with maturing oocytes (yolk length $> 100\ \mu m$) and females with arrested oocytes (yolk length $\leq 50\ \mu m$). Females maturing oocytes at 20 and 48 hr contained much higher titers of ecdysone and vitellogenin respectively (measured via radioimmunoassay and rocket-immunoelectrophoresis respectively) than did females in oogenic arrest. These experiments agree with early work in which egg maturation in *A. aegypti* was linked to the initial release of a brain hormone. In addition, the association of brain hormone release and egg maturation with the production of large amounts of ecdysone and vitellogenin lends *in vivo* support to the latest *in vitro* studies.

Control of neotenic development in a primitive termite (Isoptera: Hodotermitidae). S. Greenberg and A. M. Stuart, Dept. of Zool., Univ. of Mass., Amherst, MA 01003

Functional reproductives in colonies of the lower termites have been shown to inhibit the precocious sexual development (neoteny) of competent larvae. The mechanism of this inhibition has not been conclusively demonstrated. It has been postulated that this inhibitory influence is exerted through sex-specific non-volatile pheromones that are given off together with the feces of functional reproductives: larvae obtain the postulated inhibitory pheromones by proctodeal feeding. However, no pheromones which inhibit neotenic development in larvae have ever been isolated from any termite species. The hypothesis that the inhibitory pheromones are contained in feces from functional reproductives was tested using the west coast damp-wood termite *Zootermopsis angusticollis* (Hagen) (Isoptera: Hodotermitidae). As expected neotenic reproductive development was inhibited in colonies of larvae that contained a pair of functional reproductives. When filter paper impregnated with feces and hind gut contents from male and female reproductives and larvae were fed to groups of larvae that did not contain a pair of functional reproductives, neotenic development was actually stimulated compared to control colonies fed filter paper only. These results suggest that in the termite *Z. angusticollis,* the postulated inhibitory pheromones are not contained in feces from functional reproductives nor circulated in colonies by proctodeal feeding. Instead, proctodeal feeding may have a primarily nutritive role, in this termite species, as well as being essential for the transfer of symbiotic protozoa.

Resmethrin sprays for relief from deer flies, *Chrysops atlanticus* (Diptera: Tabanidae). E. J. Hansens, Rutgers Univ., New Brunswick, NJ 08903

Resmethrin appeared promising as a safe insecticide which would reduce deer fly annoyance to harvesting crews and other agricultural workers in fields near large salt marsh breeding areas. During two seasons resmethrin EC was applied at 0.025, 0.05, and 0.1 lb/A using conventional air-blast sprayers. Spray was directed from the edge of the fields into the vegetative barrier between these fields and the salt marsh. The sprays were applied between 7:00 and 8:45 a.m. when wind was less than 5 mph. Observations were made before treatment and approx. 1, 4, 8, 24, and 48 hr after treatment both in treated and nearby untreated areas. Effectiveness was measured by averaging 5 counts of flies taken in 10 figure-8 sweeps with an insect net around the observor's head. Pre-treatment counts varied from 15 to more than 200 deer flies/10 sweeps. Dosages of 0.1 and 0.05 lb/A reduced flies visiting a human host by more than 95% at 1 hr post-treatment, by 50–95% after 8 hr and 0 to 85% after 24 hr. Sprays with 0.025 lb/A were nearly as good. For New Jersey only label approval has been obtained for sprays for deer fly control using resmethrin EC applied at 0.025 to 0.05 lb ai/A in agricultural and recreational areas. Such applications can be expected to give greatly reduced deer fly annoyance for 1–2 days.

A field study of *Aedes sollicitans* (Walker) (Diptera:Culicidae) as a vector of filarial worms. W. M. Johnson and W. J. Crans, Mosquito Research and Control, Rutgers Univ., New Brunswick, NJ 08903

Laboratory studies have shown *Aedes sollicitans* to be a susceptible host for the larvae of *Dirofilaria immitis* (Leidy). This mosquito has long been suspected of being a major vector of dog heartworm along the New Jersey coast. To date there has been no direct field evidence to support these findings and infective stage larvae have never been recovered from wild populations. *Ae. sollicitans* were collected from CO_2-baited CDC light traps during the summer of 1978 to determine if filarial worms could be recovered at a site where dog heartworm was known to be endemic. The traps were operated once weekly from June to October at 3 sites along a 3 km transect from a breeding marsh into the upland. *Ae. sollicitans* were anesthetized, sorted and pooled into groups of 150, and infective stage filarial worms were extracted by a modified Baermann technique. Approximately 100 mosquitoes from each collection were individually dissected to detect developing stages of the parasite. Dissections revealed developing filariae as early as June, but infective stage larvae were not recovered by extraction until late August and September. Results showed that natural populations of *Ae. sollicitans* were capable of harboring filarial parasites but suggest that there may be a seasonal distribution in the transmission to vertebrate hosts.

A systematic analysis of the genus *Actia* Robineau-Desvoidy in North America with descriptions of two new species (Diptera: Tachinidae). M. A. Kamran, Dowling College, Oakdale, NY 11769

The genus *Actia* R.-D. consists of small flies which are parasitic on microlepidopterous larvae. They are an abundant group and have a worldwide distribution comprising ca 60 species.

The genus *Actia* was erected by Robineau-Desvoidy in 1830. Over the years its generic limits were invariably given a broad interpretation with the result that hundreds of specimens in various museum collections, loosely ascribed to *Actia* R.-D., in fact did not belong there. Recent authorities have looked at this assemblage much more critically and sharply defined the generic limits of the many taxa included therein.

This paper presents the important diagnostic characteristics of the tribe Siphonini, and all points of discussion relevant to generic limits in the subtribe Siphonina. A key is provided for the separation of all the known North American genera, viz., *Actia* R.-D., *Aphantorhapha* Towns., *Ceranthia* R.-D., *Ceromya* R.-D., *Chaetostigmoptera* Towns., *Peribaea* R.-D., *Pseudosiphona* Towns., *Siphona* Meig., etc.

The genus *Actia* R.-D. is reviewed. Among the recorded North American species of *Actia,* the following 4 are recognized as valid: *A. autumnalis* (Towns.), *A. diffidens* Curr., *A. interrupta* Curr., and *A. rufescens* (Greene). Two new species, *A. labellata* and *A. pauciseta,* are described. A key for the separation of the North American species is provided.

Removal method estimation of *Blattella germanica* (L.) (Dictyoptera: Blattellidae) populations. C. B. Keil, VPI and State Univ., Blacksburg, VA 24061

The estimation of cockroach population numbers is a continuing problem. Mark and recapture techniques have met with variable success. In this study, a removal method estimation was used in preparation for a sterile-male experiment on two Navy ships. The objectives were (1) to document reduction of population numbers prior to releases by estimating pre- and post-removal population size and (2) to make inferences concerning population age structures.

In cooperation with Navy entomologists, collections were made on 2 ships, one 62.5 m and the other 159.2 m in length. A synergized aerosol pyrethrin spray was used to flush cockroaches from harborages. Known or suspected harborages were then sprayed with 1% baygon in oil. All cockroaches appearing within 15 minutes of cessation of spraying were collected with a vacuum cleaner.

Two captures brought the population of the smaller ship to manageable levels. Capture probability was .6851 ± .0063. Pre- and post-removal numbers were calculated with ca. 9% coefficient of variation. The large ship required 4 collections. Capture probability was lower (.5077 ± .0021), as was the coefficient of variation (ca. 5%). All captures contained a preponderance of adults. Treatment caused a shift in the sex ratio toward a majority of adult females. Nymphal populations showed a 1:1 sex ratio. Male nymphs appeared to have 5 instars while females had six.

Assessment of insect damage to vegetation by remote sensing. V. Klemas, Univ. of Delaware, Newark, DE 19711

Insects cannot be detected directly from satellites or aircraft. However, changes in the spectral reflectance of plants can be used to assess insect damage to vegetation over large wooded and agricultural areas. Examples of successful remote sensing of insect damage include gypsy moth (*Porthetria dispar* (*L.*)) defoliation of mixed woodlands, citrus blackfly (*Aleurocanthus woglumi*) infestations in citrus groves, bark-beetle impacted conifers, and various crop diseases. Remote sensing techniques can significantly enhance the capability of ground-survey teams to assess insect damage because remote sensors map large areas at relatively low cost; use infrared wavelengths which penetrate deeply into the leaf tissue to detect early loss of plant vigor; and employ multispectral analysis techniques which can detect smaller spectral reflectance changes than the human eye. While a limited amount of ''ground truth'' is still required, remote sensing techniques are being adopted by many groups and agencies as a cost-effective tool for assessing insect and disease damage to vegetation.

Loss assessments and decision-making for the tobacco budworm, *Heliothis virescens* (F.) (Lepidoptera:Noctuidae), on Maryland tobacco. D. M. Kolodny-Hirsch and F. P. Harrison, Dept. of Entomol., Univ. of Maryland, College Park, MD 20742

Despite the economic importance of tobacco, very little information concerning tobacco injury by the tobacco budworm is available. Therefore, during the growing season of 1977 field studies were conducted to investigate this pest on air-cured tobacco in southern Maryland. Specific objectives of our research were (1) to determine the damage-density relationships resulting from artificial infestations of the budworm at several growth stages of tobacco (2) to determine the theoretical economic-injury levels (EILs) of the budworm throughout several growth stages of tobacco. Percent yield and value reduction of tobacco was correlated with larval density at several growth stages of tobacco by multiple and linear regression procedures. Results of this study show that sensitivity to defoliation varies markedly with tobacco growth. Throughout most growth stages plants were able to compensate for some degree of foliar loss. Compensation was highest during growth periods showing rapid meristematic activity. Sensitivity was most evident during root formation and production of floral parts, although markedly less during the latter. Based on the above data, EILs for the budworm were determined by integrating several economic parameters with value-density relationships. EILs indicated that throughout most developmental stages of Md. 609 tobacco, large populations of budworms can be tolerated without sufficient damage to warrant suppression. Average EILs of 25% approach optimal benefit-cost relations.

Effect of habitat characteristics on the succession of outlet-breeding black flies (Diptera:Simuliidae) in New Hampshire. D. J. Lake and J. F. Burger, Dept. of Entomol., Univ. of New Hampshire, Durham, NH 03824

Hatching patterns, adult emergence sequence and temporal succession of outlet-breeding black flies, including habitat selection in sympatric sibling species of *Simulium venustum* and *S. verecundum,* were studied in N.H. Larval populations were sampled weekly at 5 pond outlet sites in a 10 km radius around Waterville Valley. Habitat characteristics were determined by measuring the hydrological parameters, including pH, conductivity, dissolved gases, temperature, principal ions, benthic substrates and current velocities. Seventeen species were collected at study sites in 1978–79, 6 were isomorphic sibling species of *S. venustum/verecundum. S. venustum* sibling species begin hatching from late March to mid-May. The CC sibling hatches first, followed by A/C, AC (gB) and CC_2. All siblings appear to be univoltine except CC, which persists at some sites until late July. Both *verecundum* (ACD and A/C) species hatch from mid-May to mid-June, depending on water temperature at specific sites. Hatching of other outlet-breeding species after mid-May occurred simultaneously at several sites and was strongly correlated with water temperature. Adult emergence closely paralleled hatching sequence in all species. Succession patterns were strongly dependent on rate of increase in water temperature. Differences in hydrological parameters between sites were too small to explain differences in species occurrence at the study sites.

Computer-assisted instruction for pest management: ORCHARD and ALFWEEV. P. A. Logan, Univ. of Rhode Island, Kingston, RI 02881

Two interactive computer programs were written to help students learn to manage pests in dynamic agro-ecosystems. ORCHARD, written at Michigan State Univ. in 1977, considers principles of managing apple mites. Its 3 levels of difficulty require a student to 1) become familiar with simple predator-prey population dynamics (Lotka-Voltera), 2) to be aware of how changes in either the predator or the pest populations can affect the overall population stability, and 3) to make a profit in an orchard through an integrated program using predatory mites and contemporary miticides. ALFWEEV, originating at Michigan State and completed at the Univ. of Rhode Island in 1978, is a computer simulation of an alfalfa field and some of the insects found there, including alfalfa weevil (primary pest), aphids (secondary pest), weevil larval parasitoids and honey bees (non-target beneficials). Students manage pests and optimize yield (both quantity and quality of hay) by making critical day-to-day decisions on cutting or spraying strategy. Realistic weather forecasts, dynamic plant growth processes (changes in height, biomass, protein, fiber, and digestible nutrients), legal restrictions, etc. add to the game environment. Both programs are fully tested and are standardized to be easily adaptable to any computer. Both are supplemented with student guides and programmer manuals. ALFWEEV also has a separate teacher guide.

Predicting the impact of Colorado potato beetle (*Leptinotarsa decemlineata* Say) on yield. P. A. Logan and R. A. Casagrande, Univ. of Rhode Island, Kingston, RI 02881

The economic significance of CPB density as it changes in time has never been accurately quantified. We have developed an expedient dynamic predictor of CPB impact on early maturing potato varieties to serve until a more accurate multidimensional simulation can be built. To do this, we established a gradient of densities as follows: All adults in each of several 4 × 4 m plots were collected twice weekly and redistributed at 3, 1, 0.5, 0.1, and 0.05 times 1× lot density, taking advantage of the CPB's relatively sedentary behavior. Twice weekly, for 8–10 weeks, 30 counts per plot were made of egg masses per stem and larvae per stem. Of several alternatives, 3rd order exponential models (over degree-day base 10, adjusted for crop emergence date) fit these count data best. Comparison of plot yield with area under the incidence curve provided a useful, linear yield estimator. Finally, we developed a generalized incidence curve algorithm, capable of density-dependent shaping adjustment, suitable for projecting a first generation larval incidence curve (and subsequent yield loss estimate) from 1 or more early season larval samples.

Treatment of a nuclear polyhedrosis virus of *Autographa californica* Speyer with 5-Bromodeoxyuridine and determination of changes in virulence in four lepidopteran hosts. J. T. McClintock and C. F. Reichelderfer, Univ. of Maryland, College Park, MD 20742

The use of chemical mutagens to produce mutations in vertebrate viruses has been reported by several investigators. Chemical mutagenesis might provide a mechanism to increase virulence in insect pathogens, and ultimately enhance their potential for utilization in an integrated pest management program. The purpose of this study was to treat an insect virus that displays a relatively high degree of virulence for one insect and assess changes in virulence for several alternate hosts. Increased virulence with insect viruses has been achieved by serial passage and one published report exists concerning treatment with chemical mutagens which suggests that virulence might be under polygenic control.

This presentation concerns the effect of treatment of a nuclear polyhedrosis virus of *Autographa californica,* the alfalfa looper, with the chemical mutagen 5-Bromodeoxyuridine. Treatment was initially carried out in *Trichoplusia ni,* the cabbage looper, and the effect of treatment assessed in this host along with subsequent effects on virulence in *Heliothis virescens,* the tobacco budworm; *Heliothis zea,* the corn earworm; and *Spodoptera frugiperda,* the fall armyworm.

The consequences of using alternate hosts as a starting point for treatment with mutagens was found to be significantly important, as well as the overall effects of treatment on the LC_{50} and LT_{50}.

Consequences of host phenology for exotic scale insects. M. S. McClure, Connecticut Agric. Exp. Stn., New Haven, CT 06504

Two armored scales, *Fiorinia externa* Ferris and *Tsugaspidiotus tsugae* (Marlatt) (Homoptera: Diaspididae), native to Japan coexist on Eastern hemlock and on numerous other native and exotic conifers in Connecticut. Studies were conducted from 1976–1979 to examine the phenological relationships between these exotic scales and their hosts and related effects on scale success. Differences in the phenology of 14 host species and related differences in concentrations of nitrogen and water in the newest foliage in June during peak colonization by nymphs resulted in differential scale success. Nymphs which colonized hosts whose foliage was relatively immature and contained high concentrations of nitrogen and water suffered less mortality, developed faster, and ultimately laid more eggs than nymphs which colonized hosts with relatively mature foliage containing low concentrations of nitrogen and water. The phenological relationships between Eastern hemlock and its exotic scales favored the success of *F. externa* whose nymphs colonized 2 weeks earlier than nymphs of *T. tsugae*. Greenhouse experiments demonstrated that earlier colonization by *F. externa* had adverse effects on *T. tsugae* success by reducing the amount of foliar nitrogen available to *T. tsugae* nymphs and by causing a greater portion of them to colonize older, low nitrogen foliage where fewer survived. At 18 of 20 sites where these scales coexisted on hemlock during 1976, *F. externa* demonstrated superior competitive ability during three years by excluding *T. tsugae* (14 sites) or by significantly reducing its population densities. The competitive superiority of *F. externa* is likely due to its greater compatibility with hemlock phenology.

Effect of *Agromyza frontella* Randani (Diptera: Agromyzidae) on alfalfa quality and yield. G. B. MacCollom, G. Baumann and J. G. Welch, Vt. Agric. Exp. Stn., Univ. of Vt., Burlington, VT 05405

The alfalfa blotch leafminer, *Agromyza frontella,* a newly introduced alfalfa insect, was first reported in the northeast U.S. during 1968. Conflicting views on economic damage to alfalfa have in some states resulted in chemical control recommendations. Five years of field experimentation on the control of the alfalfa blotch leafminer, and its subsequent effect on yield and quality have shown no benefit from insecticidal treatment. Quality as measured by amounts of protein and percentage digestibility showed no significant differences between carbofuran and Pydrin treated plots having less than 1 mine/stem and control plots having over 30 mines/stem. No differences in yield as measured by dry weight were detected between the treated and untreated plots. Hand-separated leaflets, into blotched and unblotched samples from 1st cut alfalfa, showed no significant difference in crude protein. The average weight of a blotched leaflet was 0.9 mg less than an unblotched, indicating that one might expect yield differences, but this was not reflected in 5 years of evaluation. It is suggested that the alfalfa plant may compensate for the mining activity by putting out more leaflets, but this aspect has not yet been investigated. On the basis of these studies, the alfalfa blotch leafminer is not considered a serious alfalfa pest in Vermont, and as a result growers are advised not to initiate insecticidal treatment.

Effect of pirimicarb on natural enemies of *Myzus persicae* (Sulzer) (Homoptera: Aphididae). T. P. Mack and Z. Smilowitz, Pesticide Res. Lab., Dept. of Entomol., Pennsylvania State Univ., University Park, PA 16802

The effects of pirimicarb on the predaceous natural enemies of *M. persicae,* the green peach aphid (GPA) were determined in a potato (*Solanum tuberosum* L. var Katahdin) field as a step in the development of an integrated pest management system for the GPA on tablestock potatoes. These effects were determined by visually counting predators occurring on 24 randomly selected potato stems on several prespray and 4 postspray (20, 41, 116 and 164 hr) sample dates. The plots were treated with encapsulated methyl parathion 18 days prior to the test to facilitate GPA population growth and thus attract natural enemies. Pirimicarb was applied at 4 oz active ingredient/acre.

Coccinellid larval populations in treated and untreated plots were similar, with population peaks occurring 20, 41 and 116 hr postspray. Coccinellid pupal populations in both treatments were similar until 41 hr postspray, when the untreated population exponentially increased at a much faster rate than the treated population. *Hippodamia convergens* Guerin (Coleoptera:Coccinellidae) adult populations in treated and untreated plots were markedly different. The *H. convergens* adult population in the treated plot decreased exponentially until the end of the study, while the untreated population increased. *Coleomegilla maculata* (DeGeer) (Coleoptera:Coccinellidae) adult populations were also higher in untreated than treated plots. The adult *Coccinella transversoguttata richardsoni* Brown (Coleoptera:Coccinellidae) populations were variable in both treatments, with different peaks.

Development of adult abdomen in *Drosophila melanogaster* Meigen (Diptera: Drosophilidae). M. M. Madhavan and K. Madhavan, Biol. Dept., Holy Cross College, Worcester, MA 01610

The cell lineage of the histoblasts during metamorphosis of *Drosophila* has been studied by histological methods. The development of adult abdomen is characterized by three morphogenetic processes. (1) Mitosis and consequent increase in the number of cells in the histoblast nests. This mitotic activity parallels the increase in the titre of ecdysone. (2) Programmed cell death among the larval epidermal cells and the coordinated spreading of the histoblasts to their final positions replacing the epidermal cells. By 24 hr after pupariation, fusion of the anterior and posterior dorsal nests and that of ventral nest with spiracular anlage is complete. The dorsal nest fuses with the spiracular anlage by 28 hr and by 36–40 hr after pupariation the histoblasts have completely covered the abdomen. From the pattern of cell death, and spreading of histoblasts it is concluded that the larval cells provide a cue for the advancing histoblasts to what extent they can spread in the formation of the definitive segment border. (3) Differentiation of the imaginal epidermal cells resulting in the secretion of the cuticle and cuticular outgrowths characteristic of adult abdomen. The anterior dorsal histoblast nest gives rise to the region of the tergite bearing cuticular outgrowths, the posterior dorsal nest, possibly, to the intersegmental membrane and to the acrotergite of the following segment, the spiracular nest to the spiracle and the area surrounding it, and the ventral nest to the sternum and the pleura of the corresponding hemisegment.

Feeding behavior of Tabanidae (Diptera) on livestock. L. A. Magnarelli, Conn. Agric. Exp. Stn., New Haven, CT 06504

The feeding behavior of *Chrysops, Tabanus,* and *Hybomitra* species was observed to determine preferences in feeding sites on dairy cattle and patterns of blood ingestion. Females of 7 *Chrysops* species fed more frequently from the head areas than any other body region, whereas those of 4 *Tabanus* and 4 *Hybomitra* species commonly chose the sides, belly region, or legs. *Tabanus lineola* and *Tabanus quiquevittatus* fed avidly from the legs, and because of their abundance, these insects were of particular annoyance to livestock in pastures. Deer flies typically fed to repletion after initial feeding attempts, while horse flies (which attempted to feed from the sides and legs of animals) were frequently interrupted by host body movements and, consequently, had to pierce their mouthparts repeatedly into the animal's skin before they imbibed blood. It was not uncommon to observe *H. lasiophthalma* and *Tabanus atratus* females flying from one animal to another after unsuccessful feeding attempts. Internal examinations of host-seeking horse flies, captured in pastures by dry-ice baited canopy traps, revealed small amounts of fresh blood in midguts and only partially developed (Stage II) ovarian follicles. Capillary precipitin tests sometimes detected mixed blood from bovines and equines. Feeding success (acquisition of full blood meals) varies with the insect species, site chosen for blood ingestion, and host response to biting individuals. Repetitive feeding attempts by tabanids on different host animals reinforce the importance of these insects as potential vectors of certain pathogens by mechanical transmission.

New approaches for screening passenger baggage at U.S. international airports. J. H. Mahaney, USDA, APHIS, PPQ, Hyattsville, MD 20782

Deregulation of airlines, increasing number of wide-bodied aircraft and low fares have caused a crisis at American international airports. Since 1960 air traffic has increased nearly 600%. Federal inspectional forces at airports have increased by only 100%. Further staffing increases are not likely. Inadequate airport facilities along with inadequate staffing have caused travelers to sit for over an hr in aircraft parked outside of congested terminals. Government review agencies believe there are too many Customs inspectors at airports and that baggage spot checks would suffice. Due to intense pressure from Congress, airlines and traveling public, Customs has devised inspectional systems to expedite travelers. Newer systems as Citizen By-Pass and One Stop require only 90 seconds processing. There is even a goal of 60 seconds. As passenger traffic increases (2 million additional seats will be available for the European run this summer and there is a projection of 25% increase of travel) it is felt that restrictions will be made on Customs inspections at certain saturated airports. Recommendations may be made for "spot checks" or for the European honor system called "Red door-green door" whereby the traveler decides whether or not to go through Customs. Any such departures from present inspectional systems could be most dangerous and extremely destructive to American agriculture which is valued annually at nearly $500 billion.

Mate-seeking strategies in male flower flies (Diptera: Syrphidae). C. T. Maier, Dept. of Entomol., Conn. Agric. Exp. Stn., New Haven, CT 06504

Although male syrphid flies exhibit many different types of mate-seeking behavior, most search only near flowers and other resources utilized by females. I observed the mate-seeking behavior of males of more than 40 species in the subfamily Milesiinae and extensively studied that of *Mallota posticata* (Fabr.) and *Somula decora* Macq. in a sandy area in Illinois. Males of both *M. posticata* and *S. decora* utilized two different site-dependent searching strategies. In the morning, they patrolled flowering plants at the forest edge and in a nearby field to find feeding females. In the afternoon, they waited near treeholes, potential egg-laying sites, to intercept females arriving to oviposit. Both mate-seeking areas were aggressively defended against conspecific and some nonconspecific intruders. Resident males of *M. posticata* won 95% of the encounters with conspecific males entering their territories near treeholes. Active territorial defense (i.e. flying in response to intruders), probably the most energetically costly activity performed by males near treeholes, accounted for only 2.4% and 2.9% of the total activity budget of *M. posticata* and *S. decora,* respectively. The mating success of males at each resource is probably related to the abundance of males and females and to the degree of sperm precedence.

A comparison of laboratory-reared and wild type gypsy moth *Lymantria dispar* (L.) males (Lepidoptera:Lymantriidae) V. C. Mastro, Gypsy Moth Methods Development Center, APHIS, PPQ, USDA, Otis AFB, MA 02542

Studies carried out between 1957 and 1973 explored the effects of gamma irradiation and chemical sterilants on male gypsy moth sterility. These and other studies indicated that laboratory reared insects were inferior to wild type males. Recent improvements in laboratory culturing of the gypsy moth have made possible the mass culturing of insects for sterile male release and virus production. However, little was known about the "quality" of insects produced. The experiments described summarize two years of comparison of wild type and laboratory-reared gypsy moths. Specifically these studies compared: the periodicities of eclosion dispersal and attraction to pheromone sources; the spacial distribution of dispersing males; the ability of males to locate natural and artificial pheromone sources; and the longevity of males in the field.

Results of these trials indicate that male gypsy moths reared in the laboratory for seventeen generations are competitive with several wild strains of males. Laboratory reared males are able to locate virgin females and (+) disparlure baited traps as well as feral males. In addition periodicities of the three activities monitored are similar. Furthermore, laboratory reared males were captured in nearly the same age classes as wild males. Dispersal patterns of the strains tested were not identical; but differences did not indicate that laboratory-reared males are at competitive disadvantage.

Seasonal dispersal of pitcher plant mites (Acarina: Anoetidae). T. N. Mather and E. P. Catts, Univ. of Delaware, Newark, DE 19711

The structure of the symbiotic community of aquatic arthropods associated with pitcher plants (*Sarracenia purpurea*) was studied from sites in

New Jersey and Delaware. Comparisons were made between these communities, and similarities and differences in species abundance and richness were noted. Anoetid mites, believed to be *Anoetus gibsoni,* were most abundant from New Jersey plants, but were found from Delaware plants as well. Little more than a species description is found in the literature concerning this mite. *A. gibsoni* commonly uses a non-feeding hypopal stage for dispersal from its overwintering site inside old pitcher plant leaves. Mites overwinter as hypopi, and dispersal of mites begins in the spring after new leaves are open. Techniques were investigated to determine mechanisms of mite dispersal to new leaves. Emergence traps placed over individual overwintering leaves were serviced twice weekly and freshly emerged insects were collected and examined for paratenic mites. Newly formed leaves were marked and collected at two day intervals, and their contents were examined for mite dispersants. Insect visitors were selectively blocked from entering newly opened leaves with screens of different mesh size. Parasaggital sections of leaves glued to glass were used to observe pitcher plant biota in situ.

Development of overwintered versus summer pupae of the alfalfa blotch leafminer *Agromyza frontella* Randani (Diptera: Agromyzidae). W. K. Mellors and R. G. Helgesen, Dept. of Entomol., Cornell University, Ithaca, NY 14853

The overwintered versus summer pupae of the alfalfa blotch leafminer (ABL), *Agromyza frontella,* differed consistently in their temperature-dependent developmental rates. Overwintered pupae developed about 25% faster than summer pupae. This difference was significant in attempts to computer simulate the timing of spring emergence of the ABL. The transition from summer to overwintered developmental rate characteristics in ABL pupae was analyzed by comparing simulations using each set of rates to observed adult emergence from field samples incubated at a constant 20°C temperature in the laboratory. In August, emergence was adequately simulated using the observed pupation dates and summer pupal rates. In November, emergence was adequately simulated using the overwintered pupal rates and assuming that the pupae were at the same stage of development after completion of a presumed period of diapause development. By November, the variation in developmental state among pupae in the field had decreased compared to the time interval during which these individuals had pupated in the late summer. These developmental differences have consequences in terms of both the ecology and management of the ABL.

A new Japanese beetle trap containing pheromone and floral lure as synergistic attractants. F. W. Michelotti and J. W. Seidenberger, J. T. Baker Chemical Company, Phillipsburg, NJ 08865

A simple, effective all-plastic Japanese beetle trap has been developed consisting of a set of interlocking vanes and an hourglass-shaped disposable plastic bag that is attached through four slits and hooks. A controlled-release Hercon™ strip containing minute quantities of Japanese beetle pheromone (R,Z-5-(1-decenyl)dihydro-2(3H)-furanone) is affixed to one of the vanes through an adhesive backing. A floral lure pack, containing a 69%/31% mixture of 2-phenethyl proprionate and eugenol, respectively, is inserted through slots in the vanes. The trap is then suitably suspended by a hang-tie and the replaceable plastic bag can be conveniently disposed of when filled with beetles along with household refuse. Trap performance tests were carried out in Wooster, OH, during August 1978 in selected residential areas. The trapping devices caught large numbers of beetles (ca. 20,000) over a two-day period. Average catch per trap was over 1600 beetles. These catches were achieved without having to spray with chemicals. It was established that use of the natural sex attractant in combination with the floral lure, markedly increases the number of beetles caught when compared to captures using the floral lure alone.

Comparative effects of some insect growth regulators on development, morphogenesis, and reproduction of the female rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). J. Mkhize and A. P. Gupta, Dept. of Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

S. oryzae is an important stored products' pest throughout the world. Previous studies of the effects of insect growth regulators (IGRs) have shown that this insect pest is difficult to control, because it develops within the kernels. The objective of this study is to compare the effects of R-20458, Ro 20-3600, MV 678, methroprene and hydroprene on the developmental stages, morphogenesis, F_1 progeny, productivity index, percent reduction in adult emergence, oviposition, and egg hatchability of *S. oryzae*. These effects were studied in insects reared on IGR-treated wheat as well as in those treated topically. Both methods produced similar effects but at different dosages. All developmental stages are susceptible to the IGRs, the 4th larval and the pupal stages being the most susceptible. The number of larval-pupal and pupal-adult intermediates increased at higher dosages. Sclerotization was not uniform in pupal-adult intermediate, and in most the elytra and the hindwings were malformed. Internally, the ovarioles were attenuated. F_1 progeny decreased at higher dosages. Productivity index was lowest (2.06) and percent reduction in adult emergence highest (97.94) at a topical dosage of 0.3 μl of 30 ppm of R-2045 and Ro 20-3600, for example. None of the IGRs significantly affected oviposition and hatchability. A comparative account of the dosages used and their effects will be presented.

Effects of soybean plant populations and planting configurations on insect populations. J. W. Murphy and J. C. Smith, VPI and State Univ., Blacksburg, VA 24061

Essex variety soybeans were planted on July 5, 1978 in 12, 24 and 36-inch row spacings. Within each row spacing were populations of 1, 2 or 4 plants per square foot corresponding to 43,560, 87,120 and 174,240 plants per acre, respectively. In linear row foot comparisons, weekly shake cloth observations revealed that 36-inch row spacings had the highest numbers of the green cloverworm, *Plathypena scabra* (F.) and total numbers of phytophagous insects and predaceous insect totals. The 24- and 12-inch row spacings contained the second highest and least number of insects, respectively. There were no differences in the numbers of total phytophagous insects present in plant populations of 1, 2 or 4 plants per square foot. Significantly higher numbers of green cloverworms were found in plant populations of 4 and 2 plants per square foot compared to those found in populations of 1 plant per square foot. The greatest number of predaceous insects were found in plant populations of 4 and 2 plants per square foot though the numbers found in 2 plants per square foot were not significantly different from those found in populations of 1 plant per square foot. Generally, highest numbers of phytophagous insect totals, green cloverworms and predaceous insects were found in those planting configurations with the widest row spacings and densest plant populations within the rows. These results indicate a preference of insects in selection of soybean phytohabitat based on plant spacing.

Biological control of the greenhouse whitefly, *Trialeurodes vaporariorum* (Westw.) (Homoptera: Aleyrodidae) by *Encarsia formosa* Gahan (Hymenoptera: Aphelinidae). J. R. Nechols, Dept. of Entomol., Cornell Univ., Ithaca, NY 14853

The greenhouse whitefly, *Trialeurodes vaporariorum* (Westw.) is a serious pest of many commercially-grown greenhouse crops. Control of this pest by conventional chemical methods is difficult for a number of reasons. Biological control by its parasite, *Encarsia formosa* Gahan, on the other hand, is a practical method for controlling the whitefly—both on short- as well as long-term crops. However, to use this natural enemy effectively, growers and extension agents need to know: (1) what greenhouse temperatures to maintain; (2) how many adult parasites to release (in relation to a given host density); and (3) when these parasites should be released. From previous studies, both the optimal temperatures for the parasite (21–27°C), and the parasite:host release ratio (about 1:30) have been established. However, the problem of *when* to release adult parasites had not been well established. Therefore, I exposed each nymphal whitefly stage to *E. formosa* females. The results showed that both 3rd and 4th instar whiteflies are: (a) the most highly accepted stages by ovipositing *Encarsia* females, and (b) the most suitable stages for the parasite's development and survival. Thus, timing the release of *E. formosa* adults to coincide with these host stages results in efficient mass-rearing and successful colonization of the parasite. The application of this information to biological control trials on poinsettia and Clematis has contributed to the successful suppression of whitefly populations on these crops in commercial greenhouses.

Attack ecology of the sugar maple borer, *Glycobius speciosus* (Say) (Coleoptera: Cerambycidae). W. G. Newton, Dept. of Environ. and For. Biol., State Univ. of N.Y., Syracuse, NY 13210

This study was initiated to describe the status of sugar maples at the time of attack by the sugar maple borer, *Glycobius speciosus* (Say). A ten acre plot in a northern hardwood stand near Wanakena, NY, was chosen for examination. In 1978, all trees with evidence of sugar maple borer damage were felled. Uninfested stems were taken from the study plot as controls. Growth ring analysis was performed on three to five cross-sections from each tree. Parameters of the trees which were assessed for the time of attack include: growth rate, diameter at base, diameter at breast height, diameter at attack, height of attack, total height, aspect of attack, and aspect of scar. Trees were also described as they were at the time of study. Scars were aged, and this information was used to characterize the pattern of attack within the plot. Projections were made in order to describe the stand at each year during the infestation's history. The parameters of the trees from the time of attack were compared with the parameters at the time of study to illustrate the changes that take place after infestation. The most important factor describing trees prior to attack seems to be growth rate.

Biology of *Leptothrips mali* (Fitch) (Thysanoptera: Phlaeothripidae), a predator of orchard mites. M. P. Parrella and R. L. Horsburgh, Shenandoah Valley Res. Sta., VPI and State Univ., Steeles Tavern, VA 24476

A two-year sampling program in orchards on integrated pest control programs revealed that *Leptothrips mali* (Fitch) was one of the most abundant mite predators during 1977–78. A study of its biology was undertaken as part of an evaluation of this thrips' potential for inclusion in an integrated mite control program. Laboratory rearing conditions were 23.9° ± 1°C, 14-hr photoperiod, and 80-100% RH. A total of 1521 eggs were removed from apple leaves; 92% were on the underside of the leaves along the midvein. The majority of eggs were laid singly; however, they were occasionally found in pairs. The duration ($\bar{x}$ ± S.D. days) of the developmental stages were: egg—7.9 ± 1.3 (N = 145), first instar—6.0 ± 0.7 (N = 34), second instar—6.3 ± 0.9 (N = 18), prepupa—1.3 ± 0.4 (N = 29), pupa I—1.7 ± 0.5 (N = 19), and pupa II—4.0 ± 0.5 (N = 27). Total development time ($\bar{x}$ ± S.D.) from egg-adult was 27.0 ± 1.2 days (N = 21). Longevity of adult females ($\bar{x}$ ± 5.0 days) was 37.7 ± 25.9 and the total number of eggs oviposited per female ($\bar{x}$ ± S.D.) was 37.9 ± 30.4. The presence or absence of males did not affect female longevity or fecundity. However, *L. mali* is arrhenotokous; unfertilized eggs become males. No direct feeding on apple leaves was observed and the thrips survived ($\bar{x}$ ± S.D.) for 2.8 ± 0.83 (N = 16) days on apple leaves alone. Normal development occurred on a strict diet of *Verbascum thapsis* pollen.

Quantification of *Myzus persicae* (Sulzer) (Homoptera:Aphididae) damage to potato foliage production. F. L. Petitt, Z. Smilowitz and E. S. Nolan, Pesticide Research Lab., Pennsylvania State Univ., University Park, PA 16802

The dynamic nature of plant growth processes necessitates that when assessing damage the developmental stage of the plant must be considered as well as the abundance of the pest. Five aldicarb levels were used in field plots to foster different green peach aphid, *Myzus persicae* (Sulzer), population densities. Plant foliage and tubers were harvested weekly during the growing season and wet and dry weights were recorded. Green peach aphids were sampled weekly in each aldicarb level. Foliage production models were developed for each treatment by regression of accumulated foliage dry weight on degree-days. These models were used to estimate foliage production for each treatment. Determination of the impact of pest density on foliage production for a specific time during the season was effected by regression of accumulated foliage dry weight on green peach aphid numbers. Quantification of the damage, resulting in a relative damage index, was accomplished by regression of the percentage foliage losses on green peach aphid numbers. The relative damage index, which was expressed as percentage foliage loss per green peach aphid, varied as the growing season progressed. The seasonal damage index was the relative damage index regressed on accumulated degree-days for foliage. Creation of the seasonal damage index facilitated examination of seasonal changes in the effects of aphid feeding on foliage dry weight accumulation. Early season infestations resulted in greater percentage foliage reduction than did late season infestations in 1977.

Notal setae of first instar nymphs of five *Periplaneta* species (Dictyoptera: Blattidae). P. K. Powell, Dept. of Entomol., VPI and State Univ., Blacksburg, VA 24061

The cockroach species *Periplaneta americana, P. australasiae, P. brunnea, P. fuliginosa,* and *P. japonica* are all well known pests of man. However the morphology of the first instar nymphs of these species has not previously been well studied. Close observations of the pro-, meso-, and metanota with a scanning electron microscope at magnifications of 2000× and above revealed the presence of at least six types of setae. These can be divided into distinct groups on the basis of length, shape, and location. The types include 1) *long setae,* found on all five species and located primarily along the notal margins, 2) *moderately-long setae,* the most common setal type, found on all five species both along and within notal margins, 3) short setae, located along and within notal margins on all five species and the most dominant setal type on *P. americana* and *P. japonica,* 4) *proclinate setae,* which lie directly on the surface of the cuticle of *P. australasiae* and *P. fuliginosa,* 5) *chalazae,* located on the underside of the posterior margins of the nota of all five species, and 6) *small setae,* located on the posterodorsal margins of the nota of *P. australasiae* and *P. fuliginosa.*

The chalazae and the proclinate setae are the most unusual. Owing to the position of the chalazae and their proximity to the next posterior segment, they probably function as mechanoreceptors. The proclinate setae lie directly on the surface of the cuticle. Their sockets seem to be sunken into the cuticle.

Mating behavior of the bee *Colletes thoracicus* (Hymenoptera: Colletidae). E. G. Rajotte and R. B. Roberts, Dept. of Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

A nesting aggregation of *Colletes thoracicus* was found in the sand traps of a golf course near Trenton, N.J. in May and June, 1979. Protandrous males fly 3–8 cm above the sand searching for females. Such males will land and briefly inspect any small dark object. An attractive female (probably virgin) emerging from the ground is covered by a tumbling mass of 5–15 males. Such males also attempt mating with each other. When one effects genital union with a female, other males disperse immediately. The copulatory pair then flies in tandem to nearby trees or shrubs to complete mating. One pair remained *in copula* for approximately 3.5 minutes. The male clasps the dorsum of the female abdomen. Both face the same direction. Attractive females seem to release a sex pheromone that excites males. Males attempt copulation with freshly killed attractive females. The severed abdomen of a female seems at least as attractive as the head and thorax. Males were also attracted to the nozzle of a syringe that expelled air from a container filled with attractive females. Males attracted to the nozzle attempt to copulate with each other. In a previous study males have been observed to dig into the sand a few seconds before an emerging female had breached the surface. Behavior of these bees suggests the presence of a female sex pheromone. The rapidity with which the unsuccessful males lose interest in a copulating female suggests the presence of a pheromone which negates the effects of a female sex pheromone.

Interactions among willow herbivores as a determinant of feeding and ovipositional patterns of the imported willow leaf beetle, *Plagiodera versicolora* Laich. (Coleoptera:Chrysomelidae). M. J. Raupp and R. F. Denno, Dept. of Entomol., Univ. of Maryland, College Park, MD 20742

Current plant-herbivore theory suggests that young compared with mature foliage of long-lived plants, such as trees, is preferred by specialist herbivores. Analyses of leaves of the weeping willow, *Salix babylonica,* indicate that young leaves are less physically tough and have greater moisture and nitrogen content compared with mature leaves. Thus, young leaves appear to be a better resource than mature ones. Comparisons of the feeding behaviors of adults and larvae of *Plagiodera versicolora* indicate that adults preferentially feed on young leaves but larvae show no significant preference for either young or old leaves. While older leaves may be less nutritious, the survivorship of eggs and feeding success of young larvae may be greater on mature compared to young leaves. This was confirmed when willow leaves of different ages were surveyed and young leaves were found to be missing more often or more severely damaged by adult beetles and other herbivorous insects. Consequently, eggs and/or larvae of *P. versicolora* are probably much more likely to be disturbed or destroyed on young compared to old leaves. If egg or juvenile mortality is greater on young leaves, then selection should favor oviposition on mature foliage. Laboratory and field surveys of female egg-laying patterns confirm this prediction. It appears that the cost of laying eggs on leaves of poor nutrient quality is outweighed by a gain in juvenile survivorship there.

Insects that deform black cherry. C. O. Rexrode, Northeastern Forest Exp. Stn., Delaware, OH 43015

Many black cherry, *Prunus serotina* Ehrh. seedlings and saplings have forked or crooked main stems. This results in pole stands with a high proportion of deformed trees, and consequent reduced timber value. Results of a 2-year study of stem deformity in black cherry in Pennsylvania and West Virginia revealed that insects, diseases, forest, and browsing by deer were the major causes of injury to the terminal shoots of seedlings and saplings. Twenty-seven species of insects from 19 families and 5 orders were associated with young black cherry trees in six study areas. Of these species, *Archips* (Lepidoptera: Tortricida) accounted for up to 36 percent of the deformed stems and *Cecidomyia serotinae* O.S. (Diptera: Cecidomyiidae) accounted for 0 to 43 percent of the deformity. Reducing stem deformity in black cherry caused by these two species of insects is a complex problem because the degree of infestation varies from year to year. Although insect damage may be found in less than 20 percent of the trees in a plantation in any one year, the damage to shoots is compounded over a period of years. Also, the insects that cause the deformity have different habits and life cycles, which makes control difficult.

Sexual behavior in Hawaiian *Drosophila* (Diptera: Drosophilidae). J. M. Ringo, Univ. of Maine, Orono, ME 04469

Endemic Hawaiian species of *Drosophila* are distinguished by their diverse and spectacular morphology and mating behavior, and by their extraordinary rates of speciation. Many, perhaps hundreds, of these species have a dramatic sexual habit: mating at lek or arenas, a sexual habit once thought to be confined to birds.

The frequencies and sequencing of sexual displays in *D. grimshawi,* a "model" Hawaiian species, and in two closely related, morphologically similar species have been measured and found quite distinct. Individuals of these species can be separated with little error by discriminant functions.

The frequencies of some male displays in *D. grimshawi* are density-dependent. Increasing density causes courtship to increase. When females are present the ratio of contact to noncontact aggression increases linearly with density (fighting becomes more "intense"). The frequency of communal displays and aggression are positively correlated only when females are present, supporting the idea that the tendencies to disperse are balanced in a lek. These experiments show that whereas males initiate courtship towards male and female conspecifics at random, they respond to the presence of females in some of their other sexual behavior (aggression and communal displays).

The sequential organization of male sexual behavior is nonrandom but loosely organized. Information theoretical analysis shows differences between this behavior and the courtship rituals of continental *Drosophila* and other insect species.

Oviposition behaviour and egg distribution of the European apple sawfly *Hoplocampa testudinea* Klug. (Hymenoptera:Tenthredinidae). B. D. Roitberg and R. J. Prokopy, Univ. of Mass., Amherst, MA 01003

When presented with apple blossoms in laboratory cages, 15 of 18 (83%) female sawflies visited previously searched blossoms and 15 of 16 (94%) unsearched blossoms. Following feeding on pollen and nectar, females crawled to the receptacle where they displayed little (duration $\bar{x} = 5.7s \pm SE1.2$, $N = 14$) overt searching behaviour. Females pierced the receptacle with their ovipositors and deposited a single egg (duration of successful oviposition $\bar{x} = 121.0s \pm SE9.9$, $N = 13$). Following oviposition attempts which exceeded 45s, females fed on exudate from the oviposition puncture. Of females which visited previously un-searched blossoms, 16 of 19 (84%) attempted oviposition. Of females which visited blossoms which had just received an oviposition, 18 of 23 (77%) attempted oviposition. These data strongly suggest that, unlike another apple pest, *Rhagoletis pomonella,* female sawflies do not deposit an oviposition deterring substance. Sawfly larval infestations were normally distributed among the fruit of three sampled apple trees ($N = 208$ infestations in 838 fruit examined.) Selection pressure for development of an oviposition deterring substance in this sawfly may be weak because (1) there is normally a profusion of host blossoms, (2) larvae are mobile and move between fruits in a cluster, and (3) sawflies usually (87% of 110 cases examined) deposit an egg in only 1 or 2 of the ca. 4–5 blossoms per cluster, thus leaving the other 2–4 fruits for subsequent exploitation by larvae.

Anomalous oviposition behavior by the gypsy moth (Lepidoptera: Lymantriidae). M. C. Rossiter, State Univ. of New York, Stony Brook, NY 11794

Choice of oviposition site has been correlated with subsequent larval fitness. Previous research on the gypsy moth, *Porthetria dispar,* indicates that the female oviposits on the tree which serves as the food source (except under conditions of very high density). Because the female moth does not fly, her choice of pupation site becomes her oviposition site.

This study of oviposition preference was done in oak-pitch pine woodlands in New York, New Jersey, Pennsylvania and Massachusetts. Study sites contained gypsy moth populations with densities ranging from low to high. Oak, the predominant tree in all localities, is considered to be the most preferred food in the northeastern U.S. Trees were sampled along a transect and were scored according to tree type and presence or absence of egg masses. Analysis of the data showed that preference for oviposition on pitch pine was significant for all localities except New Jersey.

Pitch pine is not a suitable food for early larval development as instars I–

III cannot or will not eat the needles, yet females prefer pitch pine as an oviposition site. During the first 48 hr after hatch, the larvae will disperse, a passive ballooning process dependent upon the wind, if appropriate food is not encountered or if conditions are crowded. Thus, hatchlings oviposited on pitch pine must disperse to avoid starvation. This data provides a foundation for further study on the advantages and disadvantages resulting from preferential use of pitch pine as an oviposition site.

Adaptations of the fall cankerworm *Alsophila pometaria* (Harris) (Lepidoptera: Geometridae) to unapparency of host leaf flush. J. C. Schneider, Princeton Univ., Princeton, NJ 08540

The fall cankerworm is subject to selection to increase synchrony of time of egg hatch with host foliation. I have asked the question of how the fall cankerworm has reacted evolutionarily to variation in time of host foliation on two spatial scales: 1) within stand—among individual trees (1 m) and 2) among stand—among species of hosts (100 m). Hatchlings can survive for only about three days without food. Late hatch by a few days on red maple resulted in a 50% decline in potential fecundity. Red maple leaves toughen at an age of 28 ± 2 days. Thus the larval stage must coincide with an approximately 30-day long window. Individual trees tend to foliate consistently early or late. The average weight of prepupae dropping out of a given tree is positively correlated with the average weight of the apterous females climbing the tree the next fall. Thus female aptery results in oviposition on the same tree on which the female fed as a larva and presumably increases synchrony of hatch with foliation. The average date of foliation of black oaks can be six days later than that of red maples. The egg masses in a stand of black oak hatched three days later on average than those in a stand of red maple 150 m away. This is due to differences in the hatching characteristics and times of oviposition of the clones specializing on the two species. Thus differences in hatching time of host races match differences in host species' average times of foliation.

Delayed hatching of Japanese wax scale *Ceroplastes ceriferus* (F.) (Homoptera: Coccidae) in locations strongly affected by marine winds. P. B. Schultz, Virginia Truck and Ornamentals Res. Stn., Virginia Beach, VA 23455

The Japanese wax scale, *Ceroplastes ceriferus* is generally distributed throughout the southeastern states. It attacks a wide variety of ornamental plants and is very prolific. The scale overwinters as an adult female and oviposition begins in eastern Virginia in early May. Scale populations on *Ilex cornuta* var. *bufordii* at five sites in the Norfolk metropolitan area were examined weekly beginning June 12, 1978 and the percentage of hatched eggs was determined weekly at each site. All weather stations in the study area provided daily maximum and minimum temperatures which were compared to the hatching rate.

On June 12, 1978 the hatching at the southern exposure of the most urban location was 80%, while hatching had not begun at locations near Chesapeake Bay or the Atlantic Ocean. One week later all sites, except near the Atlantic Ocean, had hatching percentages of 70% or higher; only 15% were hatched at Cape Henry along the ocean. The delay in hatching of the wax scale at Cape Henry is attributed to the strong eastern airflow along the coastline that results in lower maximum temperatures in spring months. In the urban location the buildings protect the scale-infested plants from the marine breezes and produce the heat-island effect, with reduced evening cooling due to reradiation.

Application of pheromone technology in the gypsy moth program. C. P. Schwalbe and E. C. Paszek, USDA, PPQ, Otis Methods Development Center, Otis AB, MA 02542

The optically active (+) enantiomer of disparlure is a potent attractant of male gypsy moths. Traps baited with this material are effective devices for determining the occurrence and distribution of this pest. A series of field tests was conducted to define probabilities of capture of moths within various arrays of traps and to describe adult dispersal behavior in areas trapped. As trap density decreases, the probability of capturing moths declines. Trap arrays with intertrap distances (ITD) of 800 m recover ca. 1% of the released population; 22% was recovered when traps within the array were spaced 175 m apart. It appears that dispersal behavior of males is similar in trapped and untrapped areas. A grid of traps (ITD = 175 m) established on an area where moths had been released 48 hr earlier. The distribution of captured insects was similar to that found when moths were released into the trap grid. Most insects (ca. 70%) were captured in traps 275 m from the release point. These data were used to develop a system for estimating probable boundaries of infestations based upon adult distribution.

The techniques have been applied in two pilot tests in natural infestations. Both surveys yielded capture patterns which indicated the centers of the infestations. In one test area, ca. 9 sq. mi. had been presumed to be infested (based upon earlier surveys). Using the new techniques, it was found that only ca. 1 sq. mi. was actually infested, thus minimizing the area to be subsequently involved in control efforts.

Life history strategies of spring feeding forest Lepidoptera. D. F. Schweitzer, Peabody Museum, Yale Univ. New Haven, CT 06520

Data obtained from outdoor observations in CT, primarily with the noctuid tribe Lithophanini, indicate that overwintering as non-diapausing eggs results in very early, highly staggered hatching. Early spring oviposition results in similarly staggered, but later, hatching commencing near the time of spring foliation. A winter egg diapause usually results in synchronous hatching shortly after foliation of the host. However, some *Catocala* have staggered hatching despite such a diapause. Spring ovipositing Lithophanini attained closer synchrony (measured in degree-days base 5°C) of egg hatching with foliation in 1975 and 1978, years with rather cool, late springs, than in 1976 and 1977, when temperatures over 30°C caused early foliation. Such adjustable synchrony apparently reduces the risk from unfavorable weather which is especially likely to follow an early foliation, but results in less favorable food quality. Staggered hatching dates appear to maximize minimum larval fitness in an environment characterized by erratic weather and unpredictable foliation dates.

Effect of planting date on the abundance of insect pests on flue-cured tobacco. P. J. Semtner and T. R. Terrill, Southern Piedmont Res. and Continuing Education Center, Blackstone, VA 23824

Research was conducted to determine the effect of planting date on the occurrence of tobacco hornworms, *Manduca sexta* (Linneaus) (Lepidoptera: Spingidae), tobacco budworms, *Heliothis virescens* (Fabricius) (Lepidoptera: Noctuidae), and tobacco flea beetles, *Epitrix hirtipennis* (Melsheimer) (Coleoptera: Chrysomelidae) on flue-cured tobacco. Tobacco was transplanted at 10-day intervals for 3 dates beginning May 6. The experiment was established in a split-split plot design replicated 3 times.

At 2 wk after the last transplanting, tobacco flea beetles caused significantly ($P < 0.05$) more damage to tobacco transplanted on the middle date than on tobacco transplanted early or late. During 1977, the late planted tobacco had significantly fewer flea beetle feeding holes than the early or medium planted tobacco. The smaller leaf size of the late tobacco and a decline in flea beetle populations during late May and early June were responsible for reduced tobacco flea beetle feeding. When compared to early and medium planted tobacco, flea beetle populations were significantly lower on late tobacco during June. However, during August the late tobacco had the highest flea beetle populations.

Tobacco budworms were most prevalent ($P < 0.01$) on early planted tobacco, averaging 3½ times more budworms/acre than tobacco planted 10 days later and 8 times more budworms than tobacco planted 20 days later. Tobacco hornworms were most abundant on late planted tobacco.

EDNH-stimulated ecdysone production by ovaries of *Aedes aegypti* (L.) (Diptera:Culicidae). J. P. Shapiro and H. H. Hagedorn, Dept. of Entomol., Cornell Univ., Ithaca, NY 14853

In vitro evidence supports the hypothesis that the egg development neurosecretory hormone (EDNH) of the yellow fever mosquito, *Aedes aegypti,* acts by stimulating ecdysone synthesis and secretion by the ovary. Ecdysone may subsequently stimulate vitellogenin synthesis by the fat body. We studied specific aspects of the ovarian response to EDNH *in vitro.*

Incubations of ovaries with mid-brain of adult females stimulate ecdysone secretion into medium. Ovaries and incubation medium contain negligible amounts of ecdysone prior to incubation, as determined by radioimmunoassay (RIA). Upon incubation of ovaries with a saline extract of heads, nanogram quantities of ecdysone appear in the medium, with little remaining in ovaries. Actual secretion *in vivo* is indicated by distribution of ecdysone in tissues from blood-fed animals.

Ecdysone secretion by ovaries upon exposure to EDNH extracted from whole heads occurs in a time-dependent manner, beginning within one hour and continuing at least 10 hours. Secretion is dose-responsive to whole head extract.

The ovary does not develop the capability to respond to head extract until 36 hours after eclosion; maximal responsiveness is reached by 60 hours at 27°C. Development of ovarian responsiveness to EDNH may be due to the influence of juvenile hormone during the first 36 hours after emergence.

Encapsulation of pollen attractants for honey bee, *Apis mellifera* L. diets (Hymenoptera: Apidae). E. W. Herbert, Jr., H. Shimanuki and B. S. Shasha, USDA, Beltsville, MD 20705

Honey bees usually prefer to collect fresh pollen when given a free choice between pollen and pollen substitutes. The addition of attractive fractions from pollen to increase consumption of bee diets was studied. Pollen substitutes containing whey and yeast as protein sources were supplemented with polymers (2, 4, 6 or 8% dry weight) produced by encapsulation of the chloroform fractions from fresh bee collected pollen in a starch matrix. Diets containing each level of starch-encapsulated lipid was fed to four colonies of caged bees and the rate of brood rearing and diet consumption was measured for 12 weeks. The bees fed whey-yeast diet containing starch encapsulated pollen lipids were able to rear significantly more brood to the sealed stage than bees fed the whey-yeast diets without attractants. Bees fed the diets containing either 2 or 4% encapsulated lipids reared 2½ times as much brood to the sealed stage as control bees. Bees fed both levels (2 and 4%) equalled the levels by bees fed pollen. Bees fed the poorest diet (containing 8% lipid) were able to rear twice as much brood as control bees. Consumption by bees of all diets containing pollen extracts was significantly better than for bees fed the attractant free control. The addition of attractive fractions from pollen to substitute diets not only increased consumption of the diet but also eliminated the possibility of spreading chalkbrood disease, *Ascosphaera apis* by the addition of whole pollen to diets.

Establishing economic parameters for green peach aphid, *Myzus persicae* (Sulz.) (Homoptera:Aphididae) damage on commercial potatoes. Z. Smilowitz, M. E. Whalon, E. S. Nolan and C. A. Martinka. Pesticide Res. Lab., Dept. of Entomol., Pennsylvania State Univ., University Park, PA 16802

Following establishment of green peach aphid, *Myzus persicae* (Sulzer) (GPA), impact on potatoes the economic consequences of the damage must be assessed. The procedure used for GPA-CAST, a computerized pest management system for GPA on commercial potatoes incorporated a market model, management cost and pest damage index. Pest impact data were obtained from plant production models and pest densities. A matrix model was developed to estimate market values which generated 12 distinct crop values. The percent loss/GPA/leaf throughout the growing season, seasonal damage index (SDI), was interfaced with the market model to determine monetary losses. The monetary damage index (MDI), dollar loss/GPA/leaf, the monetary counterpart of SDI, was obtained as follows: MDI = SDI/FT × crop value (FT = foliage tuber ratio). Dynamic economic injury levels (EIL) were obtained from these values and insect management costs per acre. EIL = management cost/MDI. The economic threshold levels (ETL) were calculated from the EIL and the projected GPA population growth rate. The latter was based on the expected accumulated degree days (°D) for GPA at a specific interval during the growing season. A 3–4 day period between recommendation and time of application permitted growers ample time to take appropriate action. The time period averaged out to be 100 accumulated °D. Therefore, the ETL for any interval during the growing season became the EIL that occurred 100 accumulated °D prior to the current accumulated °D for GPA.

The bee louse, *Braula coeca* Nitzsch (Diptera: Braulidae), its distribution and preference for queen honey bees. I. B. Smith, Jr., and D. M. Caron, Maryland Dept. of Agric., Annapolis, MD, 21401 and Univ. of Maryland, College Park, MD 20742

A survey was conducted in Maryland to determine the infestation level of bee lice in honey bee colonies. 1881 colonies in 272 apiaries were examined during inspections by the Maryland Department of Agriculture. Bee lice were observed in 28% of the apiaries and 18% of the colonies. In apiaries with lice 50% of the colonies contained lice.

Four frame honey bee nucleus colonies were established and stocked with 50 *Braula coeca* each. One or more lice were present on 24% of the mated queen honey bees observed between August and December. Only 2% of the virgin queens observed harbored lice during the same period. Almost no lice were present on queens during preceding months. In an established apiary known to be infested with *Braula,* no lice were observed on queens April through June 15. 62% of the queens examined from June 16 through the rest of the season harbored lice and 58% of these lice were pale in color, indicating *Braula* were less than one-day old. It appears that newly emerged bee lice are attracted to mated queens.

Rearing of *Tabanus nigrovittatus* Macquart (Diptera: Tabanidae) from egg to adult. R. K. Sofield and E. J. Hansens, Dept. of Entomol. and Econ. Zool., Rutgers Univ., New Brunswick, NJ 08903

Host-seeking female salt marsh greenheads, *Tabanus nigrovittatus,* were collected from box traps on a salt marsh near Cedarville, NJ. Flies were allowed to blood feed on human forearm or restrained guinea pig. Ten egg masses were oviposited by these flies. The egg masses turned grey-brown with a chalky covering several hours after oviposition. The egg masses were loosely cemented together. Each egg mass was removed from the cage and placed on moist filter paper in a petri dish until hatching occurred. Seven masses hatched after 5 days yielding 508 larvae. Larvae were reared at 27 C in individual 8 dram vials with wet filter paper. Every 2–5 days the filter paper was changed and fresh food (house fly maggot or earth worm) provided. Larval mortality was highest in the first 40 days. Only 12.5% of the larvae survived this period. Three to five months after hatching, half the larvae were subjected to 5 C for 40 days and the remainder for 80 days. The rearing temperature was then returned to 27 C. Pupation of 26 larvae from four egg masses occurred 6–9 months after hatching. A single larva pupated 60 days after hatching. The pupal stage lasted 7–12 days. Of the 14 females reared, 7 oviposited a mass of infertile eggs, 3 took a blood meal after oviposition, and one fly oviposited a second mass of infertile eggs.

Transmission of equine babesiosis and bovine anaplasmosis by *Dermacentor albipictus* (Packard) (Acari: Ixodidae). D. Stiller, W. M. Frerichs, G. Leatch*, and K. L. Kuttler, Animal Parasitol. Inst., SEA, USDA, Beltsville, MD 20705, and *Commonwealth Sci. and Indust. Res. Org., Indooroopilly, QLD 4068, Australia

Although the 1-host winter tick, *Dermacentor albipictus,* is a common parasite of horses and cattle and is widely distributed in the U.S., its role as a potential vector of the hemoparasitic diseases equine babesiosis and bovine anaplasmosis has been little studied. Experiments to assess the vector competence of the inornate form of *D. albipictus* for the horse hemoparasite *Babesia caballi* revealed that (1) 70% of female ticks fed on an infected pony became infected, as demonstrated by Giemsa-stained smears of tick hemolymph; (2) the F_1 progeny of these females were infected transovarially and transmitted the infection when test-fed on susceptible ponies; and (3) male ticks transmitted the infection after being removed from an infected pony, held for 1 hr, and transferred to a susceptible pony. Similar experiments with this tick and the cattle hemoparasite *Anaplasma marginale* indicated that (1) nymphal ticks, fed as larvae on an infected calf, transmitted anaplasmosis when test-fed on a susceptible calf and (2) male ticks transmitted the infection after being removed from an infected calf, held for 1 or 4 hr, and transferred to susceptible calves. Tests of transovarial transmission are in progress. This is the first unequivocal evidence incriminating *D. albipictus* as an experimental vector of these pathogens and suggests that this tick may be a potential vector of these agents in nature.

Soybean foliage consumption by the adult Mexican bean beetle, *Epilachna varivestis* Mulsant (Coleoptera: Coccinellidae). I. M. Sunzenauer[1], T. Elden[2], and A. L. Steinhauer[1], Dept. of Entomol., Univ. of Maryland, College Park, MD 20782[1] and USDA, SEA, Beltsville, MD 20705[2]

Foliage feeding studies have been conducted on a variety of soybean insects, but are lacking for the adult Mexican bean beetle. Such information is needed by researchers developing decision-making models for the Mexican bean beetle in soybeans. In this study the daily feeding rate of the adult Mexican bean beetle was determined by measuring leaf area consumption. Daily oviposition rates were also obtained. Three different populations of adults were used. Population I consisted of 2nd generation adults, Population II consisted of adults which had overwintered in the field, and Population III consisted of adults which had overwintered in the laboratory. Pairs of beetles in each study were set up in petri dishes in an environmental chamber with fresh foliage, which was changed after specific time intervals, and the number of eggs was recorded. Consumed leaf area was measured by a LI-COR Leaf Area Meter from the Lambda Instruments Corporation. The mean daily leaf area consumption rates for Populations I, II, and III were 4.65 cm^2/day, 4.87 cm^2/day, and 3.80 cm^2/day respectively. The mean daily oviposition rates for Populations I, II, and III were 11.10 eggs/day, 6.77 eggs/day and 5.37 eggs/day. The lower feeding and oviposition rates for Population III resulted in part from the 7 months in cold storage.

Humidity tolerances of 3 species of phytoseiid mites (Acarina: Phytoseiidae). F. C. Swift and L. Blaustein, Rutgers-The State Univ., New Brunswick, NJ 08903

The effects of humidity on hatching success, survival of adult females, and rates of feeding and oviposition were determined for *Neoseiulus fallacis* (Garman), *Neoseiulus mckenzei* (Schuster and Pritchard), and *Amblyseius andersoni* Chant. Each factor was measured at relative humidities of 43, 51, 64, 75, 85, 90, and 97%. All experiments were conducted at 25°C and a 16:8 light-dark cycle. Eggs of *A. andersoni* showed the greatest resistance to desiccation. Also, *A. andersoni* females deprived of food survived longer than either *N. fallacis* or *N. mckenzei* at lower humidities, but the latter species survived longest at the highest humidity. Survival time over the range of humidities was exponential for all 3 species. The feeding rate of *N. fallacis* was most affected by humidity, showing approximately a 3-fold increase from the highest to the lowest humidity. Oviposition rates of *N. fallacis* and *A. andersoni* were affected only slightly by humidity, but the oviposition rate of *N. mckenzei* declined rapidly at humidities below 75%. A ratio of oviposition rate/feeding rate was used as a measure of humidity niche breadth, using Levin's formula (1968), divided by the number of resource states. According to this formula, *A. andersoni* had the widest niche breadth (0.96), followed by *N. fallacis* (0.82) and *N. mckenzei* (0.50). However, *N. fallacis* compensated by certain behavioral adaptations; namely, higher feeding rates at lower humidities and the placement of eggs in microhabitats of higher humidity.

Hudson Porta-Pak ULV Sprayer. R. Treichler, H. D. Hudson Manufacturing Company, 500 North Michigan Ave., Chicago, IL 60611

The Hudson Porta-Pak Sprayer is the only back-carried motorized unit that is designed specifically for use in ultra-low-volume pesticide application. The air volume output at full throttle is 400 CFM; the air speed at the nozzle is 230 MPH. The pesticide tank holds 106 ozs; the fuel tank 68 ozs. With a nominal discharge rate of 1.6 ozs. p.m. a full tank supplies 1 hr of application or ½ hr at a full discharge rate. Walking at 1.1 MPH, over 1 mile will be covered discharging 1 tank full at 1.6 ozs. p.m. If the application is horizontal, the 50 foot swath and 1 pesticide tank contents will cover a 7½ acre area. Hudson Porta-Pak is ideal for fruit and ornamentals. Solutions, emulsions and suspensions of wettable powders can be used to apply pesticide to trees, shrubbery and truck crops. Porta-Pak is especially useful in cattle feed lots and swine confinement areas to control mosquitoes, flies and other pests. The turbulent air stream and spray swath of 40 ft. vertical and over 50 ft. horizontal makes it especially suited for both fruit and ornamental trees. The Hudson Porta-Pak Sprayer is ideal for mosquito and fly control in parks, stadiums, playgrounds and picnic areas.

Integration of *Rhinocyllus conicus* Froelich larvae (Coleoptera: Curculionidae) and 2,4-D for control of *Carduus nutans* L. J. T. Trumble and L. T. Kok, Dept. of Entomol., VPI & State Univ., Blacksburg, VA 24061

Herbicidal effect on *Rhinocyllus conicus* Froel., a thistle head weevil, was studied by examining the mortality, emergence rates and weights of weevils developing from plants treated with 2,4-D (LVA). Infested heads, obtained by caging ovipositing *R. conicus* on primary heads of musk thistle (*Carduus nutans* L.), were treated with 2,4-D at 1.68 kg/ha 0 to 3 weeks after oviposition. Mortalities of larvae developing from untreated plants and those plants sprayed 1 to 3 weeks were significantly lower than mortality from plants sprayed within 48 hr of oviposition. The latter failed to support larval development beyond the second instar. Developmental times and weights of weevils that emerged from blooms sprayed at 1, 2, and 3 weeks were not significantly different from controls. Plants sprayed up to 2 weeks after oviposition (late-bud to early-bloom) did not produce viable seeds, but treatments at 3 weeks after oviposition (full-bloom) allowed 10% germination of seeds not damaged by *R. conicus* in primary heads, and plants survived to produce additional heads. Treatment of musk thistles with 2,4-D at late-bud to early-bloom stage of the primary heads prevented formation of viable seeds without adversely affecting *R. conicus* development.

Characterization of the structural components of the granulosis virus of *Plodia interpunctella* (Lepidoptera: Pyralidae). K. A. Tweeten, 2810 Fawkes Dr., Wilmington, DE 19808

Procedures were developed for isolation of the following structural components of *Plodia interpunctella* granulosis virus: granulin, enveloped nucleocapsids, nucleocapsids, capsids, and DNA. Biophysical and biochemical techniques were utilized to extensively characterize these components. Two molecular forms of DNA were extracted from the virus. Twenty-five percent of the DNA was isolated as covalently closed circles; the remaining seventy-five percent consisted of relaxed circular molecules. The molecular weight of the DNA was estimated to be 80×10^6 daltons from sedimentation in neutral or alkaline sucrose gradients and from electron micrographic length measurements. The polypeptide composition of each viral component was determined by sodium dodecyl sulfate discontinuous polyacrylamide slab gel electrophoresis. The enveloped nucleocapsids consisted of fifteen structural proteins ranging in molecular weight from 12,600 to 97,300. Of these proteins, eight were present in nucleocapsids. The major nucleocapsid proteins had molecular weights of 12,500 (VP12) and 31,000 (VP31). Gel electrophoresis provided evidence that VP31 was the major capsid polypeptide while VP12 was an extremely basic protein which was located inside the capsid, probably in association with the viral DNA.

Biological characterization of AMBUSH insecticide. M. Tysowsky, ICI Americas, Biological Research Station, Goldsboro, NC 27530

AMBUSH, a synthetic pyrethroid insecticide being developed by ICI Americas has been used successfully under grower conditions over the past two years for control of Lepidoptera and a number of selected Coleoptera. Rates of 0.05–0.2 lb ai/A have been evaluated on pests which attack apples, celery cole crops, corn, cotton, lettuce, potatoes, tomatoes and soybeans. However, very little has been reported concerning the biological properties of this new chemical.

AMBUSH works by contact and it is extremely effective when ingested. The material acts as disruptant. Lab and field tests have demonstrated that although insects may not die quickly, feeding stops within minutes after contact. Death may take from 24–72 hours. AMBUSH provides a high level of activity against various instars of lepidopterous larvae with some control of adults and suppression of egg hatch. Bioassays with Lepidoptera have shown that this material possesses ovicidal activity comparable to that achieved by chlordimeform. Tank mixes with other insecticides are not recommended as they can result in delayed crop maturity.

The material is environmentally sound and has a wide margin of safety to humans. However, like the natural pyrethrins, it is toxic to bees and fish. AMBUSH is very stable under sunlight conditions and it is tightly bound to soil particles.

Gas-liquid chromatographic comparisons of the cuticular lipids from male and female house crickets, *Acheta domesticus* (L.) (Orthoptera: Gryllidae). E. C. Uebel and J. D. Warthen, Jr., Biol. Act. Nat. Prod. Lab., AEQI, USDA, SEA, Beltsville, MD 20705

The main objective in the investigation of the cuticular lipids of the cricket was to check for compounds that were more abundant on the adults of one sex than on the other and which might serve as recognition pheromones for members of the opposite sex. R. Paul (Nature, 1976. Vol. 263:404–405) has demonstrated that the males of several species of ground crickets are able to detect chemical stimuli from conspecific females and respond with calling songs. The hydrocarbons and cuticular lipids from mixed sexes of house crickets have been identified by Hutchins and Martin (Lipids. 1968. Vol. 3:250–255) and Blomquist et al. (Comp. Biochem. Physiol. 1976. Vol.

54B:381–386). Gas-liquid chromatography on 2% OV 101 showed both a qualitative and quantitative similarity between the cuticular lipids present on adult females, 8th-instar males, and 8th-instar female nymphs. However, the adult males produced much more material chromatographing between 36- and 37-carbon *n*-alkane standards. This large peak of material consisted of ca 13% saturated and 87% unsaturated hydrocarbon. Approximately 33% of the 37-carbon unsaturates were monoenes and 66% were dienes. At the present time we are trying to characterize these male 37-carbon mono- and dienes by locating the positions of the double bonds and the methyl branching. Whether these male-produced monoolefins and diolefins have a communicative function between the males and females or between other males remains to be investigated.

Life history and population dynamics of tree-dwelling Homoptera. J. W. Webb, Oak Ridge Nat. Lab., Oak Ridge, TN 37830

There are few instances in which the role of the host plant in the population dynamics of herbivorous insects has been assessed in the field. Two studies of leaf feeding Homoptera were undertaken to help elucidate this role. Estimates of field population numbers and biomass were analyzed along with data on host plant physiological condition and phenology. Spring population numbers of the South African psyllid *Acizzia russellae* were correlated with nitrogen levels in the leaves of its host, *Acacia karroo*. Also, populations were almost 10 times greater on the stump sprouts of cut trees than on leaves of uncut trees. In another study, aphid populations on 8 species of North American hardwoods showed similarly dramatic growth on stump sprouts following spring cutting. Homoptera which feed on cellular contents did not increase on cut plants, probably because leaf nitrogen concentrations were no higher than in uncut plants. Phloem feeding species, however, apparently responded mainly to the increased flow rate of nutrients in growing tissues of cut trees. Estimates of consumption using aphid densities from cut plants and literature values for ingestion were about 25%–50% of leaf standing crop. The uptake and cycling of such quantities, resulting from changes in plant condition, could have significant effects on plant function. These results clearly demonstrate that the condition of the host plant is a major factor influencing population densities in phloem feeding Homoptera, and suggest that feedback effects on plants may also be important.

Distribution of *Phyllonorycter* (= *Lithocolletis*) sp. in northeastern apple orchards. R. W. Weires and J. R. Leeper, Hudson Valley Lab., Highland, NY 12528

Surveys were conducted during 1976–1978 throughout Northeastern apple orchards to determine which leafminer species were responsible for recent outbreaks. Samples of leaves were collected from beneath the apple trees during the winter months. Apple branches and leaves were collected during the summer months from several New York, Connecticut, Vermont, and Massachusetts commercial orchards. All stages were either collected or reared from the leaf samples for specialists to examine. In addition, pheromone traps containing the *Phyllonorycter blancardella* sex attractant were deployed in several New York orchards and the adult males captured were saved for identification. *Phyllonorycter crataegella* was the predominant species found in Massachusetts, Connecticut, and the area East of the Hudson River in New York state. *Phyllonorycter blancardella* was the predominant species found in Western New York, the Champlain Valley, and Vermont. Both species were found in several orchards in Ulster, Greene, Saratoga and Washington counties of New York. The pheromone trap catches were predominately restricted to detecting the *Phyllonorycter blancardella* species with only very low numbers of *crataegella* found in the traps. Both species have strains which are not controlled by the present organophosphate insecticide programs.

Seasonal history of the leafhopper complex (Homoptera:Cicadellidae) on ornamental honeylocust. A. G. Wheeler, Jr. and K. Valley, Bureau of Plant Industry, PA Dept. Agric., Harrisburg, PA 17110

Leafhoppers have been included among the arthropods known to injure ornamental honeylocust. Since little biological data were available to implicate leafhoppers as pests, we studied the complex on 'Sunburst' honeylocust by sampling weekly the terminal 36 cm of 4 branches on 2 trees at Harrisburg, PA, during 1975–77. Four common species, exhibiting spatiotemporal differences were found: *Macropsis fumipennis, Stragania apicalis, Orientus ishidae,* and *Empoasca* sp. Eggs of *M. fumipennis* hatched shortly after leaf flush; nymphs fed on petiolules and rachises and were present from mid-April to late May. Adults matured in mid-May and persisted until late July. Large populations near the sample site, in the virtual absence of honeylocust plant bud (*Diaphnocoris chlorionis*), failed to produce the leaflet distortion characteristic of mirid injury. Nymphs of *S. apicalis,* present from late April to mid-May, fed mainly on leaflets. Although adults were found until September, we were unable to determine whether this species is bivoltine. Nymphs of *O. ishidae* were found from early June to early July; adults, until late July. This introduced species fed on leaflets of water sprouts, yellowing the foliage. *Empoasca* adults, which appeared during June, may migrate each season into Pennsylvania. This leafhopper feeds mainly on the second flush of new growth and produces 2 or 3 generations by September. Our observations indicate that distortion of honeylocust foliage should be blamed on honeylocust plant bug, not on the petiolule-feeding *M. fumipennis* or other leafhoppers.

Physiological age study of five species of mosquitoes (Diptera: Culicidae) in southeastern New Hampshire. J. J. Winegar, Dept. of Entomol., Univ. of New Hampshire, Durham, NH 03824

Adult females of *Aedes excrucians, A. canadensis, A. cantator, A. vexans,* and *Coquillettidia perturbans* were collected by human-bait capture, net sweeping, and CO_2-baited CDC light traps in Exeter, New Hampshire, from June to September, during 1978. Mosquito specimens were stored at −12°C for later dissection. Physiological age for 1,818 females was determined by the Polovodova method. The data revealed that females of each species could complete a minimum of two gonotrophic cycles. *A. excrucians* and *A. canadensis* had the greatest longevity, with 12.8% of *A. excrucians* and 10.9% of *A. canadensis* surviving to become 3-parous, one *A. canadensis* female was 4-parous. Females of *A. cantator, A. vexans,* and *C. perturbans* determined to be 2-parous were uncommon, comprising 0.6% to 3.0% of total number dissected. All species studied are anautogenous. Parity data showed that *A. excrucians* and *A. canadensis* were univoltine and emerged synchronously. *A. cantator* and *A. vexans* appear to have three distinct broods, while *C. perturbans* had a single brood, but emerged relatively asynchronously. *A. excrucians* and *A. canadensis* may be epidemiologically important in southern New Hampshire, particularly as potential vectors of dog heartworm, *Dirofilaria immitis*. Absence of multiple feeding in most *A. cantator, A. vexans,* and *C. perturbans* indicates these species probably played a very minor role as disease vectors in New Hampshire, in 1978, possibly due to extremely dry weather during the summer.